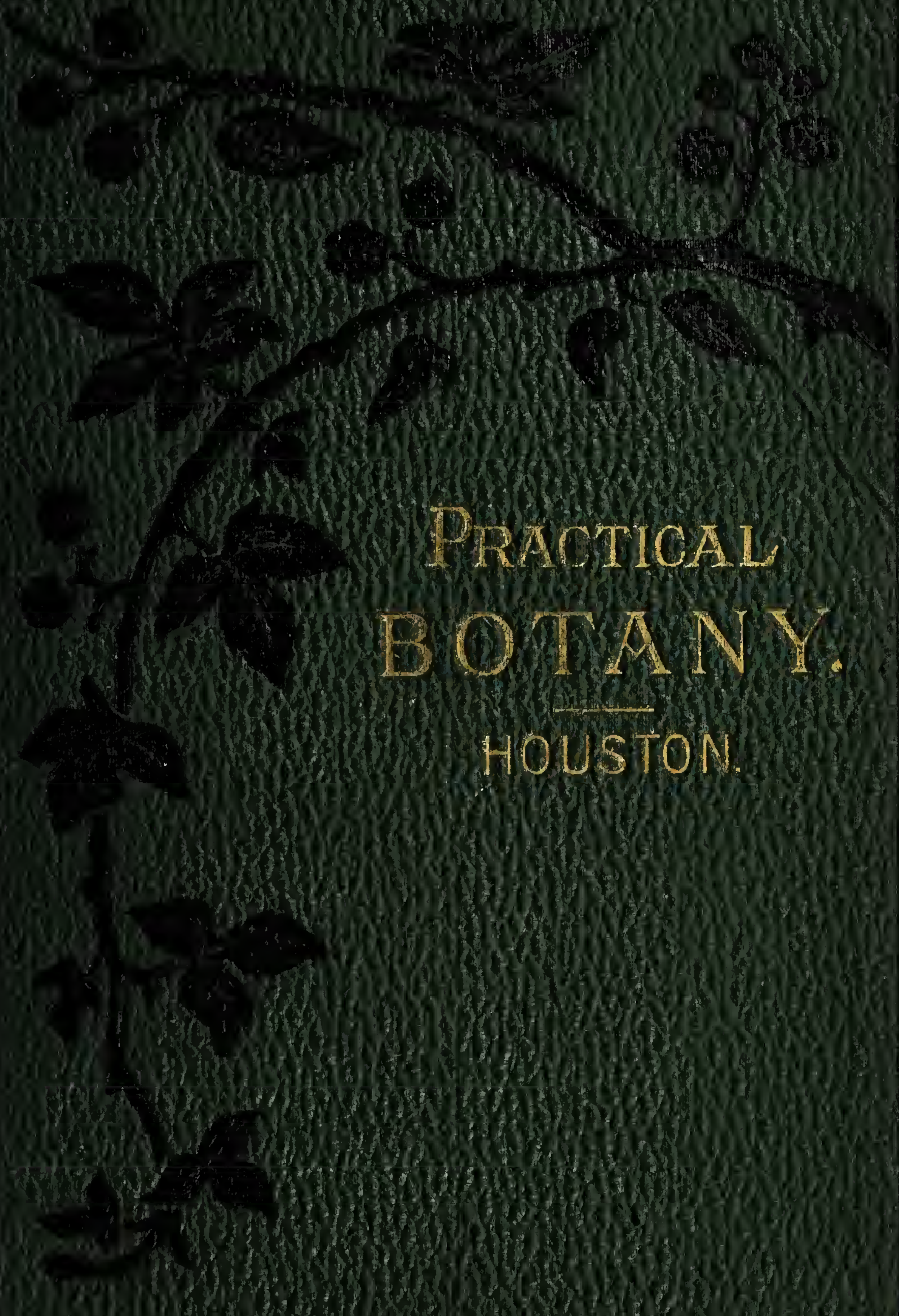

PRACTICAL BOTANY.

HOUSTON.

SCIENCE AND ART DEPARTMENT
OF THE COMMITTEE OF
COUNCIL ON EDUCATION
SOUTH KENSINGTON.

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PRACTICAL BOTANY

FOR

ELEMENTARY STUDENTS.

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PRACTICAL BOTANY

FOR

ELEMENTARY STUDENTS.

Introductory to the Systematic Study of Flowering Plants.

BY

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PREFATORY NOTE
AND
PRELIMINARY INSTRUCTIONS.

THE object of this little work is to supply a Practical Handbook for the use of Students of Elementary Botany who desire to obtain, by the examination of actual specimens, some real knowledge of the general structure of Flowering Plants, so far as may be worked out by the aid of a sharp penknife, a few dissecting needles, and an ordinary lens.

The plants selected are well known and easily procured types of the fifteen Natural Orders included in the Syllabus of the First Stage of Elementary Botany, issued by the Science and Art Department, as it is believed no better selection of Natural Orders, intended as introductory to the study of Classification, could possibly be made.

Students are required to provide themselves with the following:—

1. An Elementary Text-Book on Structural and Physiological Botany—preferably Dr. Hooker's *Primer of Botany*, published by Messrs. Macmillan.
2. A good penknife, scalpel, or razor. When cutting sections, see that the instrument is *sharp*, *clean*, and *moist*. Always keep a glass of water on the work-table.
3. A few dissecting needles. These can be easily made by mounting common sewing needles in pieces of twigs, or in ordinary pen or camel-hair pencilholders. When not in use, they should be kept stuck in corks.
4. A cutting needle. This may be made from a good crochet needle, by breaking off the notch or hook, and flattening the point of the needle for about half an inch on opposite sides, by grinding it on a wet freestone, and finishing off on an oiled hone.
5. A pair of small forceps.

6. An assortment of pins.
7. A dissecting microscope. This may be constructed by mounting an ordinary lens, free to slide on a vertical rod over a convenient stage, so that both hands may be free when dissecting anything under the lens. Mr. John Browning, optician, of 63 Strand, has, at my suggestion, recently introduced a 'Botanical Dissecting Microscope' at a very low price. It is similar in arrangement and design to one I constructed for use in my own classes. It is very convenient, and fitted with all necessary appliances.
8. A sketch book. Sketches should always be made, as afterwards directed, of any characteristic points of structure, but especially of any dissections of parts of the flower. As models of what sketches like these ought to be, the student is referred to *Floral Dissections, illustrative of Typical Natural Orders*, lithographed by the Rev. Geo. Henslow, and published by Mr. Stanford. The sketches made by the student should, however, be drawn on a much larger scale.
9. Pencils (black and coloured). After making the sketches above referred to, the different organs, or distinct parts of organs, should be diagrammatically coloured. When practicable, the corresponding part in every flower should always be distinguished by the same colour. Half-a-dozen different colours, at least, will be found necessary. Should any difficulty be experienced in obtaining these pencils, they can be supplied by the publishers.

When the selected type has been fully worked out according to the instructions, then as many of the other plants as possible which are mentioned in the list under each Natural Order should be found, examined, sketched, and described. The plants, with dissections, can afterwards be dried under pressure between old newspaper sheets, and eventually mounted (on cards or sheets of foolscap), labelled, and preserved.

D. H.

LONDON, *December* 1880.

CONTENTS.

I. The Meadow Buttercup, ... 9
II. The Wallflower, ... 17
III. The Greater Stitchwort, ... 23
IV. The Sweet-pea, ... 29
V. The Bramble, ... 39
VI. The Cow Parsnip or Hogweed, ... 47
VII. The Dandelion, ... 54
VIII. The Great Snapdragon, ... 61
IX. The White Deadnettle, ... 68
X. The White Goosefoot, ... 74
XI. The Common Hazel, ... 79
XII. The Spotted Orchis, ... 85
XIII. The Wild Hyacinth or Bluebell, ... 93
XIV. The Common Cotton-Sedge, ... 98
XV. The Common Wheat, ... 104
Synopsis of the preceding Fifteen Natural Orders, . . 111
Appendix, ... 115
Index to Plants referred to, ... 127

PRACTICAL BOTANY.

I.—THE MEADOW BUTTERCUP.

The Meadow Buttercup is a herbaceous plant, with erect branching stem, deeply divided radical and cauline leaves, and bright yellow flowers on long unfurrowed stalks, forming large and rather loose panicles; found in flower from April to September, in meadows and pastures, cultivated and waste places, throughout the kingdom.

Dig up a good specimen of entire plant while it is in flower, and if possible procure also specimens of matured fruit for examination.

Examine (A) *ROOTS.*

Note 1. Kind (fibrous).
2. Characters of fibres (stout, clustering, white).

Examine (B) *ROOTSTOCK.*

Make an upward longitudinal cut, bisecting (B) and slicing off portion of base of aerial stem.

Note 1. Origin of roots (from base and sides of rootstock).
2. Aerial stem, springing from top of rootstock, and encased in the sheaths of the radicular leaves.

Sketch.

Examine (C) *AERIAL STEM.*

Note 1. Character (herbaceous).
2. Direction (erect).

3. Form (round).
4. Covering [hairy (*hirsute*), especially towards base, where the hairs are pointing downwards (*deflexed*)].
5. The distinct nodes and long internodes.

Examine (D) *LEAVES.*

(*a*) **Radical.**

Note 1. Sheath.
2. Long, hirsute, furrowed petiole.
3. Deeply and doubly cut, lobed, hirsute blades.

(*b*) **Cauline.**

Note 1. Position on stem (alternate).
2. Insertion (*lower*, shortly petiolate; *upper*, sessile).
3. Kind (simple).
4. Margins [several, and deeply partite; *divisions* in lower wedge-shaped (*cuneate*), deeply cut and lobed; *upper*, linear and entire].
5. Surface (hirsute).
6. Venation, branching or net-veined.
7. Absence of stipules (*exstipulate*). *Sketch.*

Examine (E) *INFLORESCENCE* (a loose panicle).

Note 1. The long, round (*terete*), unfurrowed peduncles.
2. The solitary terminal yellow flowers.

Examine (F) *FLOWER.*

Snip off a flower-bud, and gently open calyx and corolla with dissecting needle, noticing how the sepals and petals overlap each other (imbricate).

Take another bud, and using a sharp knife or razor, make a transverse section a little above its base. With dissecting needle separate gently, without disturbing the relative position of the parts, the sepals from sepals, petals from petals, calyx from corolla. Examine cut face of section with lens, and observe the imbricate plan of æstivation of sepals and petals, and also the general plan of the flower. *Draw floral diagram.*

Select an open flower, having all the whorls complete. With a keen-edged knife, commencing on the stalk a little below the calyx, and cutting upwards through the receptacle, make a longitudinal section, revealing the relative positions and insertions of the various parts.

Observe (*a*) **Calyx**, inserted upon the receptacle (thalamus) and below the pistil.
(*b*) **Corolla**, also inserted upon the receptacle (hypogynous).
(*c*) **Stamens**, in several whorls, and inserted also upon the receptacle below the ovary (hypogynous).
(*d*) **Pistil**, of many small green carpels, seated upon the elevated receptacle, and of course above the insertion of the calyx (superior).

Take another flower, and examine— *Draw section.*

(*a*) **Calyx.**

Note 1. Number of sepals (five).
2. Absence of cohesion (polysepalous).
3. Length (shorter than petals).
4. Form of sepals (lanceolate and concave).
5. Colour and covering (yellowish-green and hirsute).

Sketch.

In a flower some time expanded—

Note 6. Absence of sepals (*deciduous*).

(*b*) **Corolla.**

Note 1. Number of petals (five).
2. Absence of cohesion (polypetalous).
3. Gland (*nectary*) at base on inner face of petal.

Remove petals and examine— *Sketch.*

(*c*) **Stamens.**

Note 1. Number (numerous).
2. Absence of cohesion (*free*).

Detach a stamen, and, using lens, observe—

Note 3. Prolongation of filament up back of anther (*adnate*).

Draw.

In a ripe anther—

Note 4. Lateral slits, one on each side, for escape of pollen. *Draw.*

Insert point of needle in slit, and, running it along, remove pollen. By aid of lens, the slit can now be well seen.

Remove stamens and examine—

(*d*) **Pistil.**

Note 1. Number of carpels (many).
2. Absence of cohesion (apocarpous).

Detach one of the carpels, and, using lens, examine.

Observe (α) Flattened basic portion (the ovary).
(β) Hooked, somewhat loose cellular tip (the stigma).
(γ) Short stalk (the style) connecting (α) and (β). *Draw.*

With dissecting needles — one a cutting needle — carefully remove one side of ovary wall; or with a sharp instrument make a longitudinal section of one of the carpels in position, and, using lens—

Observe 1. One-celled cavity of ovary.
2. Pale-coloured body (the *ovule*) rising obliquely upwards (ascending) from its attachment to the inner (*ventral*) side of cavity of ovary, and just immediately above its base. *Draw.*
3. Insertion of ovule by a very short stalk (*funicle*).
4. Upward continuation of funicle, forming a cord or ridge (*raphe*) along the dorsal side of the ovule to which it is adhering.
5. Inverted position of ovule (anatropous). *Draw.*

Examine (G) *FRUIT.*

Observe 1. Form (globular).
2. Character (dry).
3. Number (many) and freedom of matured carpels. *Draw.*

Make a longitudinal section cutting upwards through and equally bisecting the receptacle.

Observe 4. Indehiscent nature of carpels (achenes).
5. Position and arrangement of carpels on dry elevated receptacle. *Draw.*

Take one of the achenes, and using a cutting needle or sharp knife, carefully remove one side of the ovary wall, taking care not to detach the seed within.

Observe—Solitary seed attached to the inner angle of the single cell, and completely filling that cavity. *Draw.*

Make a vertical section of the seed, and carefully examine with lens.

Observe—A membranous coat (*testa*) which surrounds a white solid horny substance (the *albumen*), at the base of which lies a minute body (the *embryo*). *Draw.*

Write a description of plant to accompany sketches.

Description.

Root—Fibrous from sides and base of rootstock.

Rootstock—Straight.

Stem—Erect, herbaceous, round, hirsute; *hairs* spreading above, deflexed below.

Leaves—Radical and cauline, exstipulate, hirsute, especially on under surface; *veins* distinct, branching: RADICAL, petiolate; *petioles* sheathing, hirsute, furrowed; *blade* several-partite; *divisions* cuneate, deeply-cut, lobed: CAULINE, alternate, simple; *lower*, shortly petiolate, several-partite; *divisions* same as radical; *upper*, sessile; *divisions*, linear, entire.

Inflorescence—A loose panicle; *peduncles* terete, unfurrowed; *flowers* solitary, terminal, yellow.

Calyx—Inferior; *sepals*, five, polysepalous, imbricate in bud, lanceolate, concave, hirsute, yellowish-green.

Corolla—Hypogynous; *petals*, five, polypetalous, spreading, glossy, yellow, glandular at base.

Stamens—Hypogynous, numerous, free; *anthers* adnate, dehiscing longitudinally.

Pistil—Superior; *carpels* many, apocarpous; *ovary* one-celled; *ovule* solitary, ascending, anatropous; *style* short; *stigma* hooked.

Fruit—Collection of achenes on dry elevated receptacle; *seed* solitary, albuminous; *embryo* minute.

Synopsis.

The Buttercup belongs to the Class *Dicotyledons*, because—

1. The leaves are net-veined.
2. The whorls of the flower are in fives.

[3. The embryo has two seed-leaves or cotyledons.]

Note.—This latter character is too difficult for beginners to make out in the Buttercup.

The Buttercup belongs to the Division *Polypetalæ*, because—

1. The flowers possess both calyx and corolla.
2. The petals are free.

The Buttercup belongs to the Sub-division *Thalamifloræ*, because—

1. The stamens are inserted upon the receptacle (thalamus) and free from the calyx.
2. The ovary is superior.

The Buttercup belongs to the Natural Order *Ranunculaceæ*, because—

1. The leaves are alternate and exstipulate.
2. The stamens are numerous, free, and hypogynous.
3. The pistil is superior and apocarpous.
4. The seeds are albuminous.

List of other Plants belonging to the Natural Order Ranunculaceæ.

I. Marsh Marigold.—A perennial plant, with short, often prostrate, stem; radical, somewhat kidney-shaped leaves on long petioles, and large golden-yellow flowers, on stout succulent peduncles;

found in large tufts in marshy places, or by sides of water-ways; commencing to flower in March, and often lasting till summer.

Observe 1. Adventitious roots springing from lower nodes of stem.
2. Petaloid deciduous sepals.
3. Fruit, of many dry pods (*follicles*), each splitting longitudinally along its ventral face, and containing numerous seeds.
4. Prominent raphe and thickened funicle of seed.

II. Wood Anemone.—A herb, with petiolate, deeply divided, radical leaves, and solitary white flowers on long scapes; found in and near woods and copses; flowering in April and May.

Observe 1. Involucre (of three leaves).
2. Petaloid character of sepals.
3. Absence of petals.
4. Pendulous ovules.

III. Larkspur.—A herb, with slender stem; alternate, finely and much divided leaves, and showy flowers (blue, pink, or white), in terminal racemes; occasionally met with in corn-fields, but grown extensively in flower gardens, where it may be found flowering in summer and early autumn.

Observe 1. The five, coloured, irregular sepals, the upper one lengthened out into a straight, pointed, horn-like spur.
2. The presence of two small petals only, prolonged into a split spur, and developed within that of the sepal.

IV. Traveller's Joy, or Old Man's Beard.—A climbing shrub, with long stems and spreading branches; opposite, pinnately compound leaves, with twining petioles, and greenish-white, odorous flowers, in loose panicles; found in hedges and thickets; flowering in July and August.

Observe 1. Valvate æstivation of sepals.
2. Absence of petals.
3. Pendulous ovules.
4. Persistent feathery styles in fruit.

General Observations.

The following general facts should be noted respecting this Natural Order :—

1. Plants belonging to it are generally herbs, but may be shrubs (Traveller's Joy).
2. Leaves are generally alternate, but may be opposite (Traveller's Joy).
3. Flowers may be regular (Buttercup) or irregular (Larkspur).
4. Sepals may be green (Buttercup) or petaloid (Anemone).
5. Petals may be entirely absent (Anemone).
6. Ovules may be erect (Buttercup) or pendulous (Traveller's Joy).
7. Fruit may be achenes (Buttercup) or follicles (Marsh Marigold).

General Properties of Order.

Acrid, often poisonous.

Uses.

(*a*) **Pharmacy.**—Aconite (tubers, also leaves and flowering tops); hellebore (roots); monkshood (tubers); pasque-flower, a species of anemone (foliage), and others which are exotic.

(*b*) **Ornamental Plants.**—Aconite, black hellebore or Christmas rose, columbine, globe flowers, larkspur, monkshood, peony, species of clematis, species of ranunculus.

Distribution.

(*a*) **In Time.**—Represented only in recent deposits.

(*b*) **In Space.**—Abundant in temperate and cold regions of both hemispheres. Found in hot climates only in high elevations.

II.—THE WALLFLOWER.

The Wallflower is a perennial plant, with partially woody stem, alternate, simple, almost sessile, entire leaves, and large, regular, yellow or purple flowers, in a racemose inflorescence, flowering in a wild state throughout May and June upon old walls, old buildings, and rocky places near habitations, but may be found in sheltered gardens in flower during the autumn, and again in early spring.

(A) *ROOT.*

Observe 1. Woody character.
2. Branching.
3. Root-fibres covered with root-hairs.

(B) *STEM.*

Observe 1. Character (woody below, herbaceous above).
2. Covering of very short soft downy hairs (*pubescent*).
3. Branching.

(C) *LEAVES.*

Observe 1. Position on stem (alternate).
2. Insertion (sessile).
3. Kind (simple).
4. Form (lanceolate).
5. Surface (smooth, glabrous).
6. Margin (entire).
7. Venation (branching from mid-rib).
8. Absence of stipules (exstipulate).

(D) *FLOWERING BRANCH.*

Observe 1. Kind of inflorescence (raceme).
2. Absence of bracts (ebracteate).

3. Short obtuse spur at base of each of the two lateral sepals (*gibbous*).
4. Disappearance of sepals in some of the older flowers (deciduous).
5. Arrangement of limbs of petals in the form of a cross (*cruciate*).

Sketch complete plant.

(E) *FLOWER.*

Take a flower-bud and open gently the perianth whorls with a dissecting needle.

Observe imbricate arrangement of calyx and corolla.

Selecting a fully expanded flower, having all the parts complete, examine—

(*a*) **Calyx.**—Carefully remove the sepals one by one, observing—

1. Number of sepals (four).
2. Absence of cohesion (polysepalous).
3. Pouch at base of each large lateral sepal (saccate).

(*b*) **Corolla.**—Pull away the petals one by one, observing—

1. Number of petals (four).
2. Absence of cohesion (polypetalous).
3. Claws of petals (very long).

(*c*) **Stamens.**— *Draw one of the petals.*

Observe 1. Number (six).

2. Difference in length and arrangement in two whorls —four long in inner whorl, and two shorter in outer whorl (tetradynamous).
3. Thread-like form of filaments (*filiform*).
4. Termination of filaments at base of anthers (*innate*).
5. Form of anthers (lanceolate).
6. Longitudinal dehiscence of anthers on inner (ventral) side (*introrse*).

(*d*) **Green Gland** (*disk*) on receptacle surrounding base of short stamens. *Draw stamens and disk.*

Remove stamens, and examine—

(*e*) External characters of **Pistil.**

Observe 1. Linear, slightly compressed, ovary.
2. Short style.
3. Notched stigma. *Draw.*

Take another flower. Pull away the ventral and dorsal sepals, which, being inserted opposite to the long stamens, will thus expose them. Remove the two long stamens, taking care not to detach the petals. Next insert a narrow-bladed knife or cutting needle into the flower, and cut the pistil through at base of ovary; then, again inserting the blade, make a vertical section downwards through receptacle, equally bisecting what remains of the flower. Now observe on one of the sections—

1. Position of gland (disk) at base of short stamen, and bounded on each side by a claw of one of the petals.
2. Position of saccate sepal directly opposite to short stamen, its sides embracing claws of both petals, and its pouch (which may contain a quantity of honey) immediately below gland. *Draw.*

Take another flower. Push into it the very fine stem of a grass, so that its end may reach and enter one of the saccate sepals. Notice that the only way of getting there (without forcibly disturbing the parts) is to pass the probe over the stigma along the notch and down the tube formed by the pistil, a short stamen and two petal claws. Now remove probe, and observe the pollen adhering to it.

Using the same, or taking another fully expanded flower, hold it with the ventral or dorsal side towards you; then make a longitudinal section of it, passing the knife through and bisecting the lateral (pouched) sepals, taking care to expose interior of ovary. Examine section having the short stamens.

Observe 1. Slightly swollen termination of flower-stalk (thalamus).
2. Insertion of sepals upon thalamus and below pistil (inferior).
3. Insertion of petals upon thalamus (hypogynous).
4. Insertion of stamens (same as petals).
5. Green gland (disk) at base of stamens.

6. Insertion of ovary above calyx (superior).
7. Adhesion of carpels (syncarpous), and formation of a two-celled ovary.
8. Vertical median thin wall (*replum*).
9. Attachment of ovules by short stalk (funiculus) to replum (*parietal placentation*).
10. Number of ovules (many). *Draw section.*

Examine (F) *FRUIT* (a siliqua).

Observe 1. Form of pod (elongated, four-angled, compressed).
2. Character (dry and dehiscent).
3. Number of cavities (two).
4. Mode of dehiscence (from below upwards).
5. Attachment of seeds to persistent placentas (replum).
6. Number of seeds (indefinite).
7. Arrangement of seeds in one row along whole length of pod (*one-seriate*).

Draw.

(G) *SEED.*

Select a few perfectly ripe seeds. Soak them in water for ten or twelve hours, and then examine.

Note 1. Form (round or elliptical, and compressed).

Remove testa and expose embryo.

Note 2. Absence of albumen (exalbuminous), the embryo taking up the whole space inside the integument.
3. Two fleshy cotyledons.
4. Curved embryo bent down upon the edges of the cotyledons (*acumbent*). *Draw.*

Write a description of plant to accompany sketches

Description.

Root—Woody, branched.

Stem—Aerial, woody below, herbaceous above, branched, pubescent.

Leaves—Cauline, alternate, sessile, simple, lanceolate, entire, glabrous, exstipulate.

Inflorescence—A raceme.

Flowers—Regular, ebracteate.

Calyx—Inferior, polysepalous, deciduous; *sepals*, four, two lateral saccate.

Corolla—Hypogynous, polypetalous; *petals* four-clawed; *limbs* cruciate, purple.

Stamens—Inferior, six, tetradynamous; *filaments* filiform; *anthers* lanceolate, innate, introrse.

Disk—Glandular at base of small stamens.

Pistil—Superior, syncarpous; *ovary* linear, compressed, two-celled; *ovules* numerous, parietal; *style* short; *stigma* notched.

Fruit—A siliqua, four-angled, compressed; *seeds* numerous, one-seriate, exalbuminous; *radicle* acumbent.

Synopsis.

The Wallflower belongs to the Class *Dicotyledons*, because—

1. The leaves are net-veined.
2. The embryo has two cotyledons.

The Wallflower belongs to the Division *Polypetalæ*, because—

1. The flowers have both calyx and corolla.
2. The petals are free.

The Wallflower belongs to the Sub-division *Thalamifloræ*, because—

1. The stamens are inserted upon the thalamus (hypogynous) free from the calyx.
2. The ovary is superior.

The Wallflower belongs to the Natural Order *Cruciferæ*, because—

1. It is a herb.
2. The leaves are exstipulate and alternate.
3. The flowers are regular and ebracteate.
4. The sepals are four.
5. The petals are four and cruciate.
6. The stamens are tetradynamous.
7. The pistil is syncarpous and two-celled.
8. The seeds are exalbuminous.

List of a few other Plants belonging to the Natural Order Cruciferæ.

I. Shepherd's Purse.—The commonest weed we have; found in all situations; in flower from March to November. Observe its triangular laterally compressed pod (silicula).

II. Water-Cress.—Found along brooks and water-courses; in flower from May to October.

III. Wild Mustard.—A too common weed of cultivation, found in corn-fields, etc.; flowering during June and July.

IV. Candy-tuft.—Occasionally seen in corn-fields, especially in limestone districts, flowering with the corn. It is much cultivated in gardens, and can therefore be easily procured. Observe the unequal petals (two outer much the longest).

General Properties of Order.

Wholesome; generally pungent and stimulant; often acrid; occasionally anti-scorbutic.

Uses.

Food.—Turnips, radish, Kohl-rabi, horse-radish, mustard, cress, cabbage, water-cress, sea-kale, cauliflower, broccoli.

Condiments.—Mustard (flour of seeds).

Oil.—Colza oil, from a Continental species of cabbage.

Dyes.—Woad (a blue dye, obtained from dyer's woad).

Medicine.—Mustard, scurvy-grass.

Garden Plants.—Honesty, stock, candy-tuft, wallflower.

Distribution.

(*a*) **In Time.**—Represented only in the younger or tertiary formations.

(*b*) **In Space.**—Abundant in the temperate countries of the northern hemisphere.

III.—THE GREATER STITCHWORT.

THE Greater Stitchwort is a herbaceous plant, with weak slender stems, opposite, sessile, lanceolate leaves, and white star-like flowers in loose branching cymes; found in flower from April to June, in hedgerows, open woods, and bushy places.

Procure a specimen of the plant while in flower.

Examine (A) *STEM.*

Note 1. Direction (almost erect, procumbent at base).
2. Form (four-angled).
3. Surface (glabrous below, hairy above).
4. Nodes (distinct and brittle).

Examine (B) *LEAVES.*

Note 1. Position on stem (opposite).
2. Insertion [sessile, the bases uniting on each side of the stem (*connate*)].
3. Kind (simple).
4. Form [lanceolate, terminating in a long slender point (*acuminate*)].
5. Surface (glabrous).
6. Margin (entire).
7. Absence of stipules (exstipulate). *Sketch.*

Examine (C) *FLOWERING BRANCH.*

Note 1. The branching by constant forking (dichotomous); the primary axis at every fork ceasing to grow, and terminating in a flower, which always opens first (definite or cymose inflorescence).
2. The regular white flowers.
3. The presence of opposite bracts. *Sketch.*

Examine (D) *FLOWER.*

(*a*) **Calyx.**

Note 1. Number of sepals (five).

Remove three adjoining sepals with sharp knife or cutting needle.

Note 2. Absence of cohesion (polysepalous).
3. Position under ovary (inferior).
4. Lanceolate form of sepal, with dry and rather stiffly membranous margin (*scarious*) and acute apex.

Sketch a sepal.

(*b*) **Corolla.**

Remove two adjoining petals.

Note 1. Deep cleft in each petal.
2. Number of petals (five).
3. Insertion upon receptacle below ovary (hypogynous).
4. Absence of cohesion (polypetalous).
5. Length of petals (nearly twice as long as sepals).

Sketch a petal.

(*c*) **Stamens.**

Note 1. Number [ten—the five longer opposite the sepals shedding their pollen before the other five opposite the petals, and before the stigmas of the same flower are mature (*proteranderous*)].
2. Insertion [with petals (hypogynous)].
3. Thread-like form of filament (filiform). *Sketch.*

Remove a few of the stamens, so as to clearly expose—

(*d*) **Pistil,** and examine.

Note 1. Position above calyx (superior).
2. Form of ovary (globular).
3. Number of styles (three, expanding after the longer stamens have shed their pollen, and so preventing self-fertilization).
4. Number of carpels (three, as evidenced by the presence of the three styles).
5. Cohesion of carpels (syncarpous). *Sketch.*

Make a transverse section of the ovary.

Note 1. Absence of partitions or dissepiments (one-celled).
2. Number of ovules (many).
3. Position (placentation) of ovules [arranged round and growing from a central stalk, and free from the ovary wall (free central)]. *Sketch.*

Make a longitudinal section and compare with transverse one.

Examine (E) *FRUIT* (capsule).
Note 1. Kind (dry and dehiscent).
2. Form (globular).
3. Dehiscence (by six valves). *Sketch.*
4. Absence of dissepiments as in ovary (one-celled).
5. Number of seeds (many).

Examine (F) *SEED.*
Note 1. Size (small).
2. Form (somewhat kidney-shaped, compressed).

Make a transverse section, and, using lens—
Note 3. Testa (thin).
4. Albumen (in centre).
5. Embryo curved, lying immediately under the testa and surrounding the albumen. *Sketch.*

(Observe the split, running some distance along one end of embryo, separating the two opposite cotyledons.)

Write a description of plant to accompany sketches.

Description.

Stem—Erect, procumbent at base, hollow, four-angled, glabrous below, hairy above; *nodes* distinct, brittle.

Leaves—Cauline, simple, opposite, sessile and connate, lanceolate, entire, acuminate, glabrous, exstipulate.

Inflorescence—Cymose; *branching* dichotomous; *flowers* regular, white, star-like, bracteate; *bracts* opposite, lanceolate.

Calyx—Inferior, polysepalous; *sepals*, five, lanceolate, scarious, acute.

Corolla—Hypogynous, polypetalous; *petals*, five, deeply-cleft, white, twice as long as sepals.

Stamens—Hypogynous, ten, proteranderous; *filaments* filiform.

Pistil—Superior, syncarpous; *ovary* globular, one-celled; *ovules*, many, small, on a free central placenta; *styles*, three.

Fruit—A capsule, globular, six-valved; *seeds*, many, small, compressed, albuminous; *embryo* curved.

Synopsis.

The Stitchwort belongs to the Class *Dicotyledons*, because—

1. The parts of the flower are in fives.
2. The embryo has two cotyledons.

The Stitchwort belongs to the Division *Thalamifloræ*, because—

1. The stamens are inserted upon the receptacle (thalamus).
2. The pistil is superior.

The Stitchwort belongs to the Natural Order *Caryophyllaceæ*, because—

1. The leaves are entire, opposite, and grow from distinct nodes.
2. The inflorescence is definite.
3. The flowers are regular.
4. The stamens are definite.
5. The ovules are numerous, and the placenta free central.

List of a few other Plants belonging to the Natural Order Caryophyllaceæ.

I. Chickweed.—A weak, trailing, much-branched annual, with small, ovate, sharply-pointed leaves, and leafy many-flowered cymes of small flowers, on long slender peduncles; found in cultivated and waste places, by roadsides and margins of watercourses; in flower from March till October.

Observe 1. The line of hairs down one side of the otherwise glabrous stem.
2. The small petals shorter than the calyx.
3. The suppression of stamens (reduced often to five, or even less).

II. Mouse-ear Chickweed.—A coarsely-downy herb, with small petiolate radical, and sessile stem leaves, and small white flowers on dichotomous cymes, species of which may be found in almost every situation ; in flower from April till October.

Observe 1. The merely notched petals.
2. Dehiscence of cylindric capsule by ten teeth.

III. Ragged Robin.—An erect herb, with petiolate, radical, and narrow cauline leaves, and red scentless flowers, in loose terminal panicles; found in moist or marshy meadows, and banks and ditches; in flower in May and June.

Observe 1. Corolla cut up into four linear lobes.
2. Appendage at base of petal-limb.

IV. Pinks and Carnations.—Many species found wild, but well known as garden plants, with narrow grass-like leaves, and showy flowers, usually with crenate or jagged petals; found in flower during summer and early autumn.

Observe 1. The tubular five-toothed calyx.
2. The four-valved capsule.
3. The straight embyro.

General Properties of Order.

Insipid and unimportant, but sometimes saponaceous.

Uses.

Soapwort (the roots of which contain a soft gummy substance which gives a lather like soap) may be used in washing.

Ornamental Plants.—Carnations, catchflys, champions, clove pinks, picotees, pinks, sweet-william.

Distribution.

(*a*) **In Time.**—Not represented in the fossil state.

(*b*) **In Space.**—Principally inhabiting cold and temperate climates of both hemispheres, but found at great heights within the tropics.

IV.—THE SWEET-PEA.

THE Sweet-pea is a tall herbaceous plant, with weak climbing stem, alternate, stipulate, compound leaves, ending in tendrils, and irregular, somewhat showy flowers, in axillary racemes; cultivated in gardens, where it may be found in flower during summer and autumn.

Examine (A) *STEM.*
Observe 1. Direction (erect).
2. Character (herbaceous).
3. Form (angular, with prominent ridges).
4. Surface (glabrous).
5. Two opposite, longitudinal, narrow flaps of skin (*wings*) running along whole length of stem.

Sketch.

Examine (B) *LEAVES.*
Observe 1. Arrangement on stem (alternate).
2. Insertion (by winged and furrowed petioles).
3. Kind (pinnately-compound).
4. Two opposite leaflets (*a jugum*) on short stalks.
    Note (*a*) Form (ovate-lanceolate).
    (*b*) Margin (entire).
    (*c*) Surface (smooth, glabrous).
    (*d*) Venation (branching).
5. One or two pairs of opposite tendrils, sometimes branching, and one terminal one (modification of leaflets).
6. Presence of linear-lanceolate stipules (stipulate), terminating in sharp points (*acuminate*).

Sketch.

Examine (C) *INFLORESCENCE.*

Observe 1. Kind (racemose, rarely solitary).
2. Position of flowering branch (axillary).
3. The long, slender, ribbed peduncles.
4. The short, round, unribbed, hairy pedicels.
5. Absence of bracts (ebracteate).
6. The irregular flowers—the form and arrangement of the petals having a fanciful resemblance to a butterfly (*papilionaceous*). *Sketch.*

(D) *FLOWER.*

Examine (A) **Calyx.**

Observe 1. Cohesion of sepals (gamosepalous), forming a more or less bell-shaped (*campanulate*) and slightly lipped tube, with unequal lobes.
2. Number of lobes (five—two in upper lip; three in under).
3. Comparative size of lobes (*upper* broad; *lower* narrow).
4. Position (inferior).

Push a needle down the calyx-tube, and split it upwards from rim immediately above the base. Make a similar slit on opposite side, and pull down the halves, or cut them entirely away, leaving only the base of tube in which the petals are inserted.

Examine (B) **Corolla.**

Observe (*a*) *One* large upper petal (the standard), with erect or slightly recurved limb.
(*b*) *Two* lateral parallel petals (the wings).
(*c*) *Two* coherent petals (the keel), of a boat-shape form, and enclosed by (*b*).

Examine a Bud. Remove calyx, and, using a needle—

Observe 1. Imbricate arrangement of petals.
2. Position of standard (exterior).
3. Position of keel (interior).

Take a fully expanded flower.

Remove (*a*) Standard, and examine.

Observe 1. Absence of cohesion.
2. Insertion upon base of calyx-tube (perigynous).
3. Short, broad claw.
4. Broad, notched limb, with depression or groove at base of the inner face, for the reception of a part of the applied upper margins of the wings. *Sketch.*

Remove (*b*) one of the Wings.

Observe 1. Absence of cohesion.
2. Insertion (perigynous).
3. Long, narrow claw and elongated limb.
4. Cylindrical projection on upper margin at base of limb, which fits into a corresponding depression on the outer face of a similar projection in keel (*c* 4). *Sketch.*

Examine, and then remove, other wing in position.

Examine (*c*) Keel.

Observe 1. Freedom of claws at insertion.
2. Insertion (perigynous).
3. Cohesion of limbs, and formation of a deep curved trough, in which the stamens and pistil lie.
4. Projection on upper margin of limb referred to in (*b* 4). *Sketch.*

Pass dissecting needle under claws, and detach. Carefully pull away the stalk bearing the stamens and pistil.

Examine (Γ) **Stamens.**

Observe 1. Number (ten).
2. Cohesion of nine filaments along two-thirds, or thereabouts, of their entire length, forming a tube open above, with a single free stamen lying along, or in front of the cleft (diadelphous). *Sketch.*

Lift up the free stamen with a dissecting needle, pull it back, and—

Observe 3. Insertion upon base of calyx-tube (perigynous).

4. Laterally compressed split tube ensheathing pistil.
5. The free thread-like (*filiform*) terminations of the filaments alternately longer, and bearing small yellow anthers.

With narrow-bladed knife, or cutting needle, detach free stamen and sheath.

Observe (Δ) **Disk** surrounding base of pistil, and lining bottom of calyx-tube.

Examine (E) **Pistil.**

Observe (*a*) Ovary.

Note 1. Form (elongated and laterally compressed).
2. Surface [covered with long silky hairs, pressed closely to the sides (*appressed*) and pointing upwards].

Observe (*b*) Style.

Note 1. Direction (inflexed).
2. Form (flattened).
3. Surface [glabrous on one side, hairy on other (inner)].

Observe (*c*) Stigma (terminal). *Sketch.*

With a sharp-pointed cutting needle open ovary along line or seam (*suture*) on its under (dorsal) side.

Observe 1. Single-celled cavity, containing many small ovules.
2. Position of ovules (on ventral suture).

Select an ovary a little farther advanced towards maturity; this may be found in a flower in which the blossom has faded. Open it along the dorsal suture, and gently pull away the sides, tearing it along the ventral suture.

Observe 1. Alternate arrangement of ovules in two rows [(*two-serrate*), one row along edge of each half carpellary leaf].
2. Short stalk (*funicle*) by which the ovules are inserted. *Sketch.*

Take another flower, and make a longitudinal section, from below upwards, passing the knife through, and equally bisecting standard and keel. This will expose the mutual position and insertion of the individual organs. *Draw section.*

Examine (E) *FRUIT* (a legume).

Observe 1. Character (dry, dehiscent).
2. Mode of dehiscence (valvular, by both sutures).
3. Pericarp (*outer layer* brown, and covered with short, stiff hairs; *inner layer* cream-coloured, smooth, and glabrous).
4. Arrangement of seeds in two rows (one row along ventral edge of each half-carpel).
5. Inferior persistent calyx, and remnant of persistent staminal sheath.

Examine (F) *SEED.*

Soak seed in water for twenty-four hours, and then examine.

Observe 1. Form.
2. Size [almost globular (sub-globose)].
3. Surface (smooth).
4. Elliptical mark at one extremity of seed [scar indicating point of attachment of funicle (hilum)].

Gently press the moistened seed at marked end.

Observe 5. Orifice (micropyle) through which the water escapes. *Sketch.*

Carefully remove integument, and expose embryo lying within.

Observe 6. Absence of albumen (exalbuminous).

Examine (*a*) **Integument**, and—

Note 1. Outer layer (testa) thick and leathery.
2. Inner layer (tegmen) membranous.

Examine (*b*) **Embryo.**

Observe (α) The *two* large, fleshy, plano-convex cotyledons. *Sketch.*

Pull the cotyledons back, and—

Observe (β) Small cylindrical body (the axis) at hilum end.

Note 1. Slender, curved, conical end of axis (*the radicle*), which before the removal of the integument, pointed towards the micropyle.

2. Little bud (*the plumule*) forming other end or apex of axis with a pair of rudimentary leaves.
3. Depression on cotyledonary leaf where plumule lay.

Sketch.

Write a description of plant to accompany sketches.

Description.

Stem—Erect, herbaceous, angular, prominent ridges, glabrous, winged.

Leaves—Alternate, petiolate, pinnately-compound, two-jugate; *leaflets* ovate-lanceolate, entire, glabrous; *veins* branching; *tendrils* in pairs, also terminal; *stipules* linear-lanceolate, acuminate.

Inflorescence—A two or three-flowered axillary raceme; *peduncles* slender, ribbed, glabrous; *pedicels* short, round, hirsute; *flowers* ebracteate, papilionaceous.

Calyx—Inferior, gamosepalous, somewhat campanulate, two-lipped, five-lobed, glabrous, persistent.

Corolla—Perigynous; *standard* free, exterior in bud; *claw* short; *limb* erect, notched; *wings* free, converging along upper margin; *keel* compressed, curved, interior in bud; *claws* free; *limbs* coherent.

Stamens—Perigynous, ten, diadelphous; *filaments* filiform; *anthers* small.

Disk—Lining base of calyx-tube.

Pistil—Superior, apocarpous; *ovary* compressed, hirsute, with long silky appressed hairs, one-celled; *ovules*, many, on ventral suture, two-serrate; *style* inflexed, flattened, glabrous on outer face, hairy on inner; *stigma* simple, terminal.

Fruit—A legume; *seeds* sub-globose, smooth, exalbuminous; *embryo* with large, fleshy cotyledons.

Synopsis.

The Sweet-pea belongs to the Class *Dicotyledons*, because—

1. The leaves are net-veined.
2. The parts of the flower are in fives.
3. The embryo has *two* cotyledons.

The Sweet-pea belongs to the Division *Polypetalæ*, because—

1. The flowers have both a calyx and corolla.

The Sweet-pea belongs to the Sub-division *Calycifloræ*, because—

1. The stamens are inserted upon the calyx.

The Sweet-pea belongs to the Natural Order *Leguminosæ*, because—

1. The leaves are alternate, compound, and stipulate.
2. The flowers are papilionaceous.
3. The stamens are ten, and diadelphous.
4. The pistil is a one-celled superior carpel, with the ovules on the ventral suture.
5. The fruit is a legume.

List of other Plants belonging to the Natural Order Leguminosæ.

I. The Furze.—A dense, spinous, green shrub, with bright yellow flowers, intermixed with thorns, on terminal racemes; found on heaths, commons, and poor hilly pastures; in flower in February and March, and again in August and September.

Observe 1. Branches terminating in thorns (*spinescent*).
2. Leaves (simple) spinescent, or reduced to scales.
3. Bracts (small).
4. Calyx, coloured (yellowish), membranous, cleft into two parts, almost to the base (*two-partite*), the *upper* lobe two-toothed, the *lower* three-toothed.

5. Corolla, *petals* narrow, shortly-clawed; *keel* and *wing* round at the ends (*obtuse*).
6. Stamens, with all the filaments united (*monodelphous*), forming an unslit tube.
7. Pistil, with capitate stigma.
8. Pod (short and hirsute).

II. The Common Broom.—A glabrous shrub, with long, wiry, green branches, and large, bright-yellow, pedicellate flowers, in a racemose inflorescence; found on dry heaths, commons, and hilly wastes; flowering in spring and early summer.

Observe 1. Branches (prominently ridged).
2. Leaves, compound, with one, two, or three leaflets (sometimes none), with minute stipules.
3. Calyx (two-partite, *lobes* minutely toothed).
4. Corolla [*keel* bent downwards (*deflexed*) after flowering].
5. Stamens (monodelphous).
6. Style (coiled).
7. Pod twisted after dehiscence.

III. Common Bird's-foot.—A spreading hairy annual, with slender, prostrate, or partly-ascending stem, pinnate leaves, and small pink or white red-veined flowers, in axillary peduncled heads; found in dry pastures; flowering in spring and summer.

Observe 1. The minute membranous stipules.
2. The pinnate bracts.
3. The slender indehiscent pod, breaking up when ripe into many one-seeded joints.

IV. White Clover.—A perennial plant, with creeping stem, ternary, compound, stipulate leaves on long petioles, and capitate flowers on very long peduncles; found in meadows, pastures, and by roadsides; in flower from May till October.

Observe 1. Adhesion of stipules to petioles.
2. Short pedicles (recurved in fruit).
3. Adhesion of claws of wings, and keel of corolla, to staminal tube.

4. Stamens (diadelphous, the *upper* one being entirely free).
5. Small indehiscent pod, covered by persistent standard.

V. Laburnum.—A tree, with smooth stem, pinnately-compound leaves, and bright-yellow flowers, in pendulous racemes; a cultivated exotic, flowering in early summer.

VI. Meadow Pea.—A weak, much-branching annual, with trailing, sometimes climbing, angular stem, stipulate, pinnate leaves, ending in short tendrils, and bright-yellow flowers, on a racemose inflorescence; found in moist meadows, hedges, and copses; in flower from June till September.

Observe 1. The creeping rootstock.
2. The large spreading stipules.
3. The long peduncles.

VII. Vetches. — Climbing herbs, with weak, sometimes branching stem, and pinnately-compound stipulate leaves, generally ending in either simple or forked tendrils, and blue, purplish, or pale-yellow flowers, in axillary racemes; found wild, but extensively cultivated as forage plants; in flower all through the summer.

Observe 1. The numerous leaflets.
2. Adhesion of wings to keel.
3. Upper stamen entirely free, or united only in the middle.
4. Pods sometimes with very few seeds.

N.B.—The *Common Bean* is a species of vetch.

General Observations.

The following facts should be noted and remembered respecting this Natural Order:—

1. Plants belonging to it may be herbs (Sweet-pea), shrubs (Furze), or trees (Laburnum).
2. The compound leaves may be pinnate (Sweet-pea) or digitate (Clover).

3. The leaflets may sometimes be modified into tendrils (Sweet-pea) or spines (Furze).
4. The stamens may be monodelphous (Furze) or diadelphous (Sweet-pea).
5. The pod may be dehiscent (Sweet-pea) or indehiscent (Bird's-foot).

General Properties of Order.

Generally wholesome, often nutritious, sometimes purgative, diuretic, or astringent, rarely poisonous.

Uses.

Food.—Beans—haricot (dried seeds), kidney, French, and scarlet-runner (green, unripe pods), broad (fresh seeds); peas, lentils, ground-nut, gram, tamarinds (pulp of pod).

Forage Plants.—Clover, lucerne, sainfoin, white lupin, vetch.

Pharmacy.—Balsams of Peru, Tolu, and Copaiva; broom-tops, Calabar beans, Cassia pulp, cowhage or cowitch (hairs of pod); gums, Arabic, Senegal, and tragacanth; kino (juice), liquorice root, logwood, red sandal-wood, senna (leaves).

Woods.—Camwood, ebony, laburnum, locust-tree, rosewood, shota, tamarind.

Dyes.—Brazil wood, camwood, indigo (obtained by soaking the whole plant in water), logwood, red sanders-wood, sappin-wood.

Various.—Broom-twigs (for making baskets, etc.), catechu (used in tanning), copal (juice used in making varnish), ordeal bean (a poison), Tonquin beans (used to scent snuff).

Ornamental Plants.—Acacia, bladder senna, coral-tree, laburnum, lupins, scarlet-runners.

Distribution.

(*a*) **In Time.**—Represented in the tertiary formation.

(*b*) **In Space.**—Widely and abundantly dispersed throughout the world, from the equator to the Arctic circle, but chiefly inhabiting the north temperate regions.

V.—THE BRAMBLE.

The Bramble is a straggling prickly shrub, with alternate, compound, stipulate leaves, and white or pink regular flowers, in terminal panicles; found in flower from July to September, and abundant everywhere in hedges, thickets, woods, and waste places throughout the British Isles.

Procure portion of a stem bearing a flowering branch, also, if possible, specimens of the fruit.

Examine (A) *STEM.*
Observe (1) Character (woody).
(2) Surface appendages [hooked prickles (scansorial organs)].

On a young shoot make two parallel and longitudinal incisions through the skin, at a distance (say) of half an inch, unite two near ends with a transverse cut, and pull back the flap of skin.

Observe (3) Superficial origin of prickles (modified hairs).
Sketch.

Examine (B) *LEAVES.*
Observe 1. Position on stem (alternate).
2. Insertion (petiolate).
3. Kind (compound).
    (*a*) Division (usually pinnately, three to five foliate).
    (*b*) Form of leaflets (ovate).
4. Surface [hirsute; petiole and mid-rib (under side) armed with prickles].
5. Margin (coarsely, irregularly serrate).
6. Venation (branching or reticulated).
7. Presence of stipules [adherent (*adnate*) to petioles].

Examine (C) *FLOWERING BRANCH.*

Observe 1. Kind of inflorescence (panicle).
2. Presence of bracts (bracteate).
3. Persistence of calyx (seen in the withered-looking flowers passing into fruit).
4. Deciduous character of petals.

Select a flower-bud just beginning to expand, and, using the dissecting needle, make out—

1. Imbricate arrangement of calyx lobes.
2. Imbricate arrangement of petals.
3. Alternation of petals with calyx lobes.

Make a transverse section of another flower-bud, and from it, using lens, draw a plan of flower.

Make a longitudinal section of a closed flower-bud, and, using lens—

Observe 4. Incurvation of stamens. *Sketch.*

Examine (D) *FLOWER.*

Make a longitudinal section of a flower, by removing a segment of the calyx tube, wide enough to expose interior without cutting through the ovaries. With dissecting needle or narrow-bladed knife remove pistil, leaving a fragment of the elevated receptacle upon which the ovaries are seated to mark the position of pistil. Using the lens—

Observe 1. A thickened shining ring (*disk*) at base of stamens, lining inside of broad calyx tube, and surrounding mark showing position of ovaries.
2. Moist secretion covering surface of disk.

Select a fully expanded flower, having all the parts complete—

Observe 1. Union of sepals at base (gamosepalous).
2. Number of calyx lobes (five).

Pull away the petals one by one, and—

Observe 3. Absence of cohesion (polypetalous).
4. Form of petals (orbicular and concave).
5. Claw of petal (very short). *Sketch a petal.*

Take another flower, and make a longitudinal section, equally bisecting it.

Observe 1. Insertion of calyx (inferior).
2. Insertion of petals [upon calyx under margin of disk (perigynous)].
3. Insertion of stamens (perigynous).
4. Number of stamens (many).
5. Cohesion of stamens (free).
6. Smallness of anthers.
7. Insertion of carpels (superior, on an elevated convex receptacle).
8. Number of carpels (many).
9. Absence of cohesion (apocarpous).
10. Styles—(*a*) Form (long, slightly compressed).
(*b*) Position [not borne quite on summit of ovary (*subterminal*)].
11. Stigmas [simple, beset with silky hairs (*plumose*)].
Sketch.

Detach one of the carpels, and make a transverse section through its ovary, examine with lens, and—

Observe 1. *Two* ovules, side by side (*collateral*), in a one-celled ovary. *Sketch.*

Take another carpel, and make a longitudinal section of ovary, or dissect away one side of the ovary wall, under lens, with a pair of very fine needles, and—

Observe 2. Position of placenta (on roof of cavity).
3. Direction of ovules (suspended or pendulous).
Sketch.

Examine (E) *FRUIT.*

Observe 1. Inferior persistent calyx.
2. Withered persistent stamens.
3. Collection of small, black, succulent, globular bodies (drupels).

Make a longitudinal section through entire fruit, and—

Observe 4. Elongated receptacle upon which the drupels are sitting.

Remove one of the drupels, and examine.

Observe 1. Character (indehiscent, succulent).
2. Persistent style attached to summit.
3. Glossy and membranous outer wall of pericarp (*epicarp*).

Open epicarp, and find in juicy pulp [the middle wall of pericarp (*mesocarp*)]—
4. Small ovate stone.

Place the stone in a notch in a piece of cork, and with a knife make a longitudinal section in a direction parallel to its slightly compressed sides.

Examine face of one of the cut sections.

Observe 1. Stony wall [the inner coat of pericarp (*endocarp*)] forming a one-celled cavity, and enclosing a solitary seed.

Remove carefully the half seed from each section, and examine.

Find 1. Tough, rather thick, testa.
2. *Two* fleshy, plano-convex cotyledons, making up (almost) entire mass of seed (exalbuminous).
3. Small radicle lying between inner (plane) faces of cotyledons.

Write a description of plant to accompany sketches.

Description.

Stem—Long, climbing, branching, sometimes arched; *branches* woody, prickly; *prickles* hooked.

Leaves—Alternate, petiolate, compound, pinnately three, four, or five foliate; *leaflets* ovate, coarsely and irregularly serrate, hirsute; petioles and mid-rib (under-side) prickly, stipulate; *stipules* adnate to petioles.

Inflorescence—A panicle; *flowers* white, bracteate; *bracts* linear-lanceolate.

Calyx—Inferior, gamosepalous, five-lobed, imbricate in bud, persistent.

Corolla—Perigynous, polypetalous; *petals*, five, orbicular, concave, shortly clawed, imbricate in bud.

Stamens—Perigynous, free, numerous, incurved in bud, persistent.

Pistil—Superior, on elevated receptacle, apocarpous; *carpels*, many; *ovary* one-celled; *ovules*, two, collateral, pendulous; *style* long, subterminal; *stigma* simple, plumose.

Fruit—A collection of drupels; *seeds* pendulous, exalbuminous; *cotyledons*, two, fleshy, plano-convex; *radicle* small.

Synopsis.

The Bramble belongs to the Class *Dicotyledons*, because—

1. The leaves are net-veined.
2. The parts of the floral whorls are in fives.
3. The embryo has two cotyledons.

The Bramble belongs to the Division *Polypetalæ*, because—

1. The flowers have both calyx and corolla.
2. The petals are free.

The Bramble belongs to the Sub-division *Calycifloræ*, because—

1. The stamens are seated upon the calyx.

The Bramble belongs to the Natural Order *Rosaceæ*, because—

1. The leaves are alternate and stipulate.
2. The flowers are regular.
3. The sepals and petals are imbricate in bud.
4. The stamens are numerous, perigynous, and incurved in bud.
5. A disk is present, and lines the calyx tube.
6. The seeds are exalbuminous.

List of other Plants belonging to the Natural Order Rosaceæ.

I. The Sloe or Black-thorn.—A branching shrub, with black bark, the branches very widely divergent, and tipped by thorns, and white, nearly sessile, flowers, solitary or in pairs, appearing before the alternate, simple, ovate leaves; found in hedges and thickets; in flower in March and April.

Observe 1. Deciduous calyx.
2. Presence in flowers of only one carpel.
3. The fruit a small, globular, nearly black, astringent drupe.

Observation.—The plum and damson are said to be cultivated varieties of the Sloe.

II. The Wild Strawberry.—A low perennial, with slender running stem, tufted, radical, three-foliate leaves, and white or yellow flowers on erect scapes; found in woods under hedges and other shady places; in flower during April and May.

The *Garden Strawberry* may be found in flower throughout nearly the whole summer.

Observe 1. Adventitious roots springing from under surface of each node of runner.
2. Bracteoles (two) at base of calyx.
3. Numerous carpels, seated on a convex receptacle.
4. Solitary ascending ovule in each ovary.
5. Fruit, of many minute achenes, sunk in surface of enlarged fleshy receptacle.

III. Apple.—A tree, with spreading branches, shortly petiolate simple leaves, and white or pinkish-white flowers, on short racemes or branches of six to ten; known in its wild state as the *Crab-tree*, and found in copses and hedges; flowering in spring.

Observe 1. Carpels cohering below, and adnate to calyx tube.
2. Number of styles (five).
3. The large, fleshy, five-celled fruit (pome), with cartilaginous cell-walls, each cell containing two seeds (pips).

IV. The Dog Rose.—A perennial plant, with long arching branches, armed with hooked prickles, pinnate leaves, and pink or white, usually sweet-scented, flowers; found in hedges and thickets; in flower from June till August.

Observe 1. Mossy excrescences or galls, *Rose Bedeguars*, frequently found on branches. Cut one across, and observe cavities containing larvæ.
2. Persistent ovoid calyx, with contracted mouth.
3. Disk lining calyx tube, and almost closing its mouth.
4. Fruit of many bony achenes, enclosed within the fleshy calyx tube.

V. Meadow Sweet.—A stout annual, with glabrous, reddish stem, large pinnate leaves, and small yellowish-white sweet-scented flowers, in compound corymbose cymes; found in meadows, and by sides of waterways; in flower from June till August.

Observe 1. Under surface of leaves (white and downy).
2. The twisted carpels, each with two or more pendulous ovules.
3. Small spirally-twisted follicles (five to eight), each with a few seeds.

General Observations.

The following facts should be noted respecting this Natural Order:—

1. Plants belonging to it may be herbs (Strawberry), shrubs (Sloe), or trees (Apple).
2. The leaves may be simple (Apple) or compound (Meadow Sweet).
3. The calyx may be inferior (Bramble) or superior (Apple), persistent (Rose) or deciduous (Sloe).
4. The carpels may be one (Sloe) or more (Strawberry), free (Bramble), connate (Apple), or adnate to calyx tube (Apple).
5. The ovules may be pendulous (Bramble) or ascending (Strawberry).
6. The fruit may be drupes (Bramble), achenes (Rose), a pome (Apple), or follicles (Meadow Sweet).

General Properties of Order.

Various, but as a rule wholesome; some are astringent. Parts of the plant may be poisonous, owing to the presence of hydrocyanic acid (*e.g.* seeds in drupaceous fruit).

Uses.

Fruit.—Almond (seed), apple, apricot, blackberry, cherry, hawthorn, loquat, medlar, nectarine, peach, pear, plum, quince, raspberry, rowan, and strawberry.

Pharmacy.—Sweet and bitter almonds (seeds), cabbage-rose (petals), cherry-laurel (leaves), kousso (flowers and tops), dog-rose (calyx tube and disk in fruit), red rose (petals), tormentilla (rhizome).

Various.—Oil (attar or otto) of roses from petals, soap-woad (saponaceous). Some species yield timber.

Distribution.

(*a*) **In Time.**—Represented in the chalk by a species of the same genera as the apple.

(*b*) **In Space.**—Represented in all regions from the equator to the polar circle, but especially inhabiting cool and temperate climates.

VI.—THE COW PARSNIP OR HOGWEED.

The Cow Parsnip or Hogweed is a coarse gigantic herb, with branching fistular stem, pinnately-lobed, compound, widely sheathing leaves, and small white flowers, in many-rayed compound umbels; flowering from June to August, in meadows, moist woods, hedges, and pastures.

Procure the plant while in flower. It will also be necessary to collect specimens of the ripe fruit.

Examine (A) *STEM.*
Observe 1. Direction (erect).
2. Form (round, furrowed).
3. Surface [rough, with rigid scattered hairs (*hispid*)].
Sketch.

Make a longitudinal section of portion of stem, letting the knife pass through a node.

Observe 4. Interior cavity running through whole length of internode (*fistular*).
5. Transverse partition at node. *Sketch.*

Examine (B) *LEAVES.*
Observe 1. Alternate arrangement on stem.
2. Well-developed sheath.
3. Furrowed petiole.
4. Kind (compound).
  (*a*) Divisions (one to three pinnate).
  (*b*) Form of segments (variable, but lobed).
5. Surface (rugose and hirsute).
6. Margin (coarsely toothed).
7. Venation (branching). *Sketch.*

Examine (C) *FLOWERING BRANCH.*

Observe 1. Inflorescence (a many-rayed compound umbel).
2. Bracts, few or absent, at base of compound (*primary*) umbel; whorl (*involucre*) at base of separate (*secondary*) umbel.
3. Flowers small, white, the outer ones larger, petals very unequal. *Sketch.*

Snip off a flower-bud, and gently open corolla with dissecting needle.

Observe 4. Valvate arrangement of petals.

Examine (D) *FLOWER.*

The **Calyx** is adherent to ovary. The limb is often wanting, but if present—

Observe 1. Five superior minute teeth.

In **Corolla**—

Observe 1. Freedom of petals (polypetalous).
2. Number of petals (five).
3. Form (broadly obcordate, point incurved).
4. Insertion upon ovary (epigynous). *Sketch.*

In **Stamens**—

Observe 1. Number (five).
2. Adhesion (epigynous).
3. Position between petals and below margin of disk.
4. Incurvature of filaments.
5. Attachment of anthers by the back to the slender tip of the filaments (*versatile*). *Sketch*

Pull petals and stamens away, leaving only one of each to show relative position of parts.

Observe 1. Inferior compressed ovary.
2. Fleshy two-lobed disk, seated upon ovary and adnate to base of styles.
3. Two short styles, with obtuse stigmas. *Sketch.*

Cut a transverse section of ovary, and make out, with lens—
4. Two cells, with section of ovule in each cell. *Sketch.*

On another ovary (better select one passing into fruit) make a longitudinal section through narrower diameter, and compare with transverse.

Observe 5. One pendulous ovule in each cell. *Sketch.*

N.B.—If you cannot clearly see that the ovules are pendulous, raise them gently from below with point of dissecting needle, when they may then be distinctly seen hanging from roof of cell.

Examine (E) *FRUIT* (cremocarp).

Observe 1. Kind (dry, indehiscent).
2. Form (orbicular, flattened).
3. Longitudinal commissure splitting the fruit into two parts (*mericarps*).
4. Slender axis (*carpophore*) split to base, and standing between the mericarps, which are attached to and pendent from the extremity of each arm. *Sketch.*

Detach a mericarp, and examine (using lens).

Observe 5. The two faces; the inner (*ventral*) flat or very slightly concave, the outer (*dorsal*) slightly convex and traversed by longitudinal ridges.
6. The *five* longitudinal ridges,—two (one on each side) lateral or *marginal* ridges running the whole length of pericarp, carrying on their outer margins a membranous flap (*wing*); a *median* ridge; and two (one on each side of median) *intermediate* ridges.
7. *Four* club-shaped longitudinal marks on dorsal side,—*one* lying between each two ridges, and extending from top to below the middle; two similar shaped but broader marks on ventral side. *Sketch.*

Cut the mericarp in two across the middle, and remove a thin slice or transverse section. Place on a piece of white paper, and examine with lens.

Observe 8. The cut ends of four tubes or oil canals (*vittæ*) on the dorsal side; *two* similar canals, but much wider, on the ventral side, the tubes on both sides corresponding in position to the marks in (7).

In another mericarp make a longitudinal section along its broader diameter, and—

Observe 9. Membranous perianth adhering closely to seed.
10. Seed with quantity of horny albumen.
11. Minute embryo situate in albumen at upper end of seed.

In a fruit that has been soaked in water for several hours, make a few careful cuts, removing very thin slices until the embryo can be distinctly seen; then remove it carefully with a dissecting needle, and examine.

Observe 1. Form (cylindrical and club-shaped).
2. Radicle (at narrow end).
3. Cotyledons (*two*) at broad end.

Write a description of plant to accompany sketches.

Description.

Stem—Erect, fistular, round, furrowed, hispid.

Leaves—Alternate, compound, petiolate; *petiole* sheathing, furrowed, one to three pinnate; *segments* broad, lobed, toothed, hirsute.

Inflorescence—A compound umbel; *flowers* small, white, involucrate.

Calyx—Gamosepalous, adnate to ovary, five-toothed.

Corolla — Epigynous, polypetalous; *petals*, five, unequal, broadly obcordate; *point* incurved, valvate in bud.

Stamens—Epigynous, five, between the petals; *filaments* incurved; *anthers* versatile.

Disk—Fleshy, epigynous, two-lobed.

Pistil—Inferior, syncarpous; *ovary* two-celled; *ovules*, one in each cell, pendulous; *styles*, two, short; *stigmas* obtuse.

Fruit—A cremocarp; *mericarp* orbicular, dorsally flattened; *ridges* distinct; *marginal* winged; *vittæ* club-shaped;

commissure broad; *carpophore* divided; *seeds*, two, one in each mericarp, albuminous; *embryo* minute, superior.

Synopsis.

The Cow Parsnip belongs to the Class *Dicotyledons*, because—
1. The leaves are net-veined.
2. The whorls of the flower are in fives.
3. The embryo has two cotyledons.

The Cow Parsnip belongs to the Division *Polypetalæ*, because—
1. The petals are free.

The Cow Parsnip belongs to the Sub-division *Calycifloræ*, because—
1. The sepals are connate.
2. The stamens are epigynous and inserted beneath the disk.

The Cow Parsnip belongs to the Natural Order *Umbelliferæ*, because—
1. The stem is furrowed and jointed.
2. The leaves are alternate and sheathing.
3. The flowers are umbellate.
4. The petals are five.
5. The stamens are five, epigynous, and incurved.
6. The ovary is inferior, with two styles.

List of other Plants belonging to the Natural Order Umbelliferæ.

I. Penny-wort.—A perennial plant, with slender, creeping, white stem, orbicular leaves, attached by rather long petioles, and small flowers, in simple axillary umbels; found in bogs, marshes, edges of ponds and lakes; in flower from May till August.

Observe 1. Absence of bracts.
2. Petals *not* inflexed, valvate in bud.
3. In fruit—
    (*a*) Narrow commissure.

(*b*) Undivided carpophore.
(*c*) Absence of vittæ.

II. Hemlock.—A tall, branching, fœtid annual, with stout, leafy, furrowed stem, large, much-divided leaves, and white flowers, in compound umbels; found on banks of streams, by roadsides, along hedgerows, and other situations; in flower during June and July.

III. Caraway.—An erect branching annual, with glabrous stem, finely pinnately, compound leaves, on long sheathing petioles, and irregular umbellate flowers; found in moist meadows, pastures, and waste places, but often cultivated; flowering in spring and early summer.

Observe 1. Tap-root.
2. The notched petals.
3. The oblong, curved, highly aromatic fruit.

IV. Hedge Parsley.—An erect hispid herb, with solid stem, wiry branches, pinnate leaves, with numerous close-set leaflets, and small white and pink umbellate flowers, on long slender peduncles.

Observe 1. Fruit covered with rough incurved bristles.
2. Seeds with deep ventral groove.

General Properties of Order.

Poisonous and acrid; aromatic and stimulant, sometimes nutritious.

Uses.

Culinary.—Carrot (root), celery (the blanched petioles), parsnip (root), samphire (leaves for pickles).

Flavourers.—Anise (fruit), caraway (fruit), chervil (young leaves), fennel (leaves and fruit), parsley (foliage).

Pharmacy.—Ammoniacum (gum-resin), anise (fruit), asafœtida (gum-resin), caraway (fruit), coriander (fruit), dill (fruit), galbanum (gum-resin), hemlock (leaves), water-fennel.

N.B. — The following plants are poisonous : — Cowbane, dropwort, fools-parsley, hemlock, water-hemlock, wild chervil.

Distribution.

(*a*) **In Time.**—Not represented.

(*b*) **In Space.**—Widely distributed, but abounding principally in temperate regions.

VII.—THE DANDELION.

The Dandelion is a herbaceous perennial plant, with radical, usually deeply pinnatifid leaves, and solitary involucred head of yellow ligulate flowers, on a long glabrous hollow scape ; flowering from March to October, in meadows and pastures, cultivated and waste places, throughout the kingdom.

Procure a complete plant.

Examine (A) *ROOT* (long, stout, black).

(B) *ROOTSTOCK* (short, erect, perennial).

In (B)—Note 1. Scars left by previous year's leaves.
2. Fragments of sheaths of last year's leaves.
3. Present year's foliage growing from apex.

Make a longitudinal section of (A) and (B), bisecting entire plant.

Note 1. Presence of copious milky juice in all parts of the plant.
2. Arrangement of leaves upon sides and top of rootstock.
3. Hollow peduncles (*scapes*) springing from axis of leaves. *Sketch.*

Examine (C) *LEAVES.*

Note 1. Position (radical).
2. Insertion (by short petioles with sheathing bases).
3. Kind (simple).
4. Form (oblong-obovate or spathulate).
5. Margin [almost entire to deeply pinnatifid, with triangular toothed segments directed downwards (*runcinate*)].
6. Surface (smooth, glabrous).
7. Venation (reticulated).
8. Absence of stipules (exstipulate). *Sketch.*

Examine (D) *FLOWERING STEM.*

(*a*) **Peduncle** (scape).

Note 1. Form (round).

2. Surface (glabrous).

(*b*) **Involucre.**

Note 1. Number of whorls (several).

2. Erect bracts of inner whorl.

3. Recurved bracts of outer whorl.

Examine an unexpanded flower-head.

Note 4. Imbricate arrangement of bract leaves. *Sketch.*

(*c*) **Flower-Head** (capitulum).

Cut a vertical section.

Note 1. Flat naked receptacle.

2. Sessile insertion of florets.

3. Centripetal inflorescence. *Sketch.*

Detach (E) a fully expanded *FLORET* from circumference of receptacle, and make out the following points :—

(*a*) **Inferior Ovary.**—Note its partial elongation above into a short beak.

(*b*) **Cup-shaped Disk** seated upon ovary (epigynous).

(*c*) **Superior Calyx** formed of rings of hairs (pappus).

(*d*) **Corolla.**

Note 1. Adhesion to top of ovary (epigynous).

2. Cohesion of petals (gamopetalous).

3. Number of corolla teeth (five).

4. Form of corolla [strap-shaped (*ligulate*) above ; the one-sided development of the narrow corolla tube below]. *Sketch.*

Insert a dissecting needle into corolla, and split the tube open for a short distance.

Examine (*e*) **Stamens.**

Note 1. Insertion of stamens upon corolla tube (epipetalous).

2. Number of stamens (five).

3. Cohesion of anther lobes forming a tube or collar round style (*syngenesious*).

Split the corolla tube along its whole length, and hold or pin it back against a card.

Observe (*f*) Slender cylindrical **Style** passing up from ovary through the syngenesious anthers and bifurcating at top, forming two slender recurved arms bearing the stigmas. *Sketch.*

With cutting needle carefully remove one side of wall of ovary, taking pains not to injure contents.

Observe (*g*) One-celled **Ovary**, containing one erect ovule. *Sketch.*

Examine (F) *FRUIT.*

Note 1. Character (dry, indehiscent).

2. Form and colour (elongated, slightly compressed, ribbed, brown).

3. Surface [armed above the middle with short sharp-pointed cones (*muricate*)].

4. Long slender beak, crowned with tuft of silky hairs (*pappus*). *Sketch.*

Using two needles (one a cutting needle), carefully dissect away (under lens) half of the thin wall (*pericarp*), taking extreme care not to injure seed or detach it from the placenta.

Note 5. One-celled cavity, containing a solitary erect seed. *Sketch.*

Write a description of plant to accompany sketches.

Description.

Root—Stout, branching, black.

Rootstock—Short, erect, perennial.

Leaves—Radical, shortly petiolate ; *petioles* sheathing ; simple, oblong-obovate, runcinate, glabrous, smooth, exstipulate.

Inflorescence—A capitulum.

Scape—Round, glabrous, hollow.

Involucre—Several-whorled ; *bracts* imbricate in bud, linear ; *inner*, erect ; *outer*, recurved.

Florets—Sessile upon a flat naked receptacle.
Calyx—Superior, pappose, persistent.
Corolla—Epigynous, gamopetalous, five-toothed, ligulate, yellow.
Stamens—Five, epipetalous, syngenesious.
Ovary—Inferior, one-celled; *ovule* solitary, erect; *style* long, bifid; *stigmas*, two.
Fruit—An achene, elongated, slightly compressed, muricate, beaked; *beak* long, terminating in a spreading pappus.

Synopsis.

The Dandelion belongs to the Class *Dicotyledons*, because—

1. The leaves are net-veined.
2. The corolla and stamenal whorls are in fives.
3. The embryo has two cotyledons.

The Dandelion belongs to the Division *Gamopetalæ*, because—

1. It has both a calyx and corolla present.
2. The petals are united.

The Dandelion belongs to the Natural Order *Compositæ*, because—

1. It is a herb.
2. The florets are in involucrate heads.
3. The stamens are five, and epipetalous, with syngenesious anthers.
4. The ovary is inferior and one-celled.
5. The ovule is solitary and erect.
6. The fruit is an achene.

List of other Plants belonging to the Natural Order Compositæ.

I. Coltsfoot.—A perennial herb, with creeping mucilaginous and bitter rootstock, and large spreading heart-shaped leaves; flowering in March and April, and found especially upon damp heavy soils.

Observe 1. White cottony coat on under surface of young leaves.

2. The long *scapes* appearing in early spring, before the foliage leaves, with alternate tongue-shaped scales pressed closely to them (*appressed*), and bearing solitary, bright yellow, erect, expanded flower-heads, or drooping buds.

3. *Bracts*, linear, in one row, with a few small outer ones.

4. *Outer* (*ray*) *florets*, ligulate and female.

5. *Inner* (*disk*) *florets*, tubular, male.

II. Common Groundsel.—An annual plant, with erect branching stem, alternate pinnatifid irregularly coarsely-toothed leaves, and small cylindrical heads of yellow tubular florets in terminal corymbs; found in waste and cultivated places in flower all the year round.

III. Daisy.—A stemless perennial, with radical leaves, and solitary heads of yellow disk and white ray florets; found in pastures flowering the whole year round.

Observe 1. The ray (ligulate) florets are one-sexual (female).

2. Absence of pappus in all the florets.

IV. Cornflower, or Bluebottle.—An erect annual, with branching stem, sessile leaves, and solitary heads of purplish central florets, and large bright-blue outer florets, upon long cottony peduncles; found in corn-fields in flower from June to September.

Observe that the outer florets have neither stamens nor pistils (*neuter*).

V. Spear Thistle.—A stout erect biennial, with winged prickly stem, spinous-toothed leaves, and purple florets in large ovoid heads; found in fields and waste places, flowering from July to October.

Observe 1. Leaves rough and prickly on upper surface, cottony beneath.

2. Heads growing in bundles (*fascicled*).

3. Involucre cottony, with spinous bracts.

4. Receptacle deeply pitted.

5. Florets, corollas are all tubular.
6. Stigmas *not* bifurcating.

VI. Hawkweed.—There are many species of this plant, but they all resemble one another in being perennial herbs, full of a milky juice, and covered with stiff or glandular hairs, with radical, and alternate, sessile, cauline leaves, and imbricated involucres surrounding solitary or panicled heads of yellow ligulate florets; found common in all situations, flowering from early summer to late autumn.

General Observations.

The following general facts should be noted respecting this Natural Order:—

(*a*) Florets in the same head may be all ligulate (Dandelion), or the outer only may be ligulate and the inner tubular (Daisy), or they may be all tubular (Thistle).

(*b*) The florets may be two-sexual (disk florets of Groundsel), male (inner florets of Coltsfoot), female (ray florets of Daisy), or neuter (outer florets of Cornflower).

General Properties of Order.

Bitter, aromatic, often narcotic, but various.

Uses.

(*a*) **Food.**—Artichokes (tubers), endive (foliage), lettuce (foliage). Many others are forage plants (dandelion, daisy, thistles, etc.).

Food Adjuncts.—Chicory, the ground root used in the adulteration of coffee; tarragon, an ingredient in salads and pickles, also for flavouring vinegar; wormwood, from which the French drink absinthe is made; a species of yarrow is used by the Swiss as tea.

(*b*) **Pharmacy.**—Arnica (root), chamomile (the flowers), dandelion (root), pellitory (root), santonica (flowers).

(*c*) **Various.**—Dye from flowers of safflower; 'immortelles,' the dried heads of everlasting; oil from seeds of sunflower; infusion of coltsfoot used as a rustic remedy for colds.

(*d*) **Ornamental Plants.**—Dahlia, chrysanthemum, sunflower, everlasting, marigold, asters, golden-rods, cineraries, zinnia.

Distribution.

(*a*) **In Time.**—Represented only in deposits of the present age.

(*b*) **In Space.**—Very widely dispersed throughout all regions within the limits of growth of flowering plants.

VIII.—THE GREAT SNAPDRAGON.

THE Great Snapdragon is an erect, somewhat shrubby plant, with branching stem; opposite, entire, simple leaves, and large, showy, commonly purplish-red, personate flowers, in dense terminal racemes, found wild in clefts of rocks, old walls, and stony places; flowering from July to September, but much cultivated in gardens, where it may be found in flower during the earlier months of the year.

Examine (A) The *STEM.*
Note 1. Direction (erect).
2. Character (woody below, herbaceous above).
3. Branching.
4. Surface [glabrous below, slightly hairy (hirsute) above].

(B) The *LEAVES.*
Note 1. Position on stem (opposite, upper may be alternate).
2. Insertion (by short petioles).
3. Kind (simple).
4. Form (narrow-lanceolate).
5. Surface (smooth and glabrous).
6. Margin (entire).
7. Venation (branching from mid-rib).
8. Absence of stipules (exstipulate).

(C) The *INFLORESCENCE.*
Note 1. Character (indefinite or centrepetal).
2. Kind (a raceme).
3. Presence of ovate bracts, terminating in long narrow points (*acuminate*).
4. The erect hairy pedicels.

(D) The *FLOWER.*

Observe (*a*) The slightly irregular **Calyx,** covered with short stiff hairs.

Note 1. Number of sepals (five).

2. Cohesion at base (gamosepalous).

Observe (*b*) The showy irregular **Corolla.**

Note 1. Cohesion of petals (gamopetalous).

2. The compressed tube, slightly prolonged below, and in front into a short pouch or sac (*saccate*).

3. The two lips (*bilabiate*), the *upper* erect, with recurved margins ; the base of the *under* pushed upwards, forming a broad yellow 'palate,' completely closing throat or entrance into tube (*personate*).

4. Number of petals five, as evidenced by the two erect lobes of the upper lip and the three (mid-lobe smallest) spreading unequal lobes of the under lip. *Draw.*

Press the sides of the upper part of the tube. The lips 'gape.'

Observe (*c*) The four **Stamens,** two long and two short (*didynamous*), lying (with style of pistil) against the posterior wall of corolla-tube.

Open corolla-tube and dissect calyx and corolla (with stamens) carefully away.

Observe (*d*) The green annular **Disk** surrounding base of ovary.

(*e*) The syncarpous **Pistil,** with ovate ovary, long simple style, and shortly two-lobed stigma. [Use lens.]

Draw.

Lay pistil aside for a time. Take a fresh flower, and make a longitudinal section, equally bisecting the lips and exposing interior of ovary.

Note 1. Insertion of calyx (inferior).

2. Insertion of corolla (hypogynous).

3. Presence of a liquid in pouch.

4. Long downy hairs on inner surface of palate, probably covered with pollen.

5. Insertion of stamens upon corolla-tube (epipetalous).
6. Flexure near base of filament, with ring of downy hairs at bend.
7. Form of anther cells (oblong).
8. Disk at base of ovary.
9. Insertion of ovary (superior). [Use lens.]
10. Position of placenta (axillary).
11. Number of ovules in each cell (numerous).

Draw.

Now take pistil (*e*) which you laid aside, make a transverse section of ovary, and—

Note 12. Number of cells (two).

Compare also with longitudinal section as to (10) and (11) above.

Draw.

Examine (E) *FRUIT* (capsule).

Observe 1. Form (oblique).
2. Persistent calyx at base.
3. Portion of persistent style in front and a little below apex.
4. Dehiscence by pores [*one* situate above style, and *two* (one on each side, with many teeth) below].

Draw.

Make a transverse section, and—

Observe 5. Number of cells [two (bilocular)], separated by a broad partition (*septum*).
6. Number of seeds (many). *Draw.*

In another specimen, make a longitudinal section from below upwards, passing the knife between the two lower pores, and bisecting base of persistent style.

Observe 7. *Upper* cell dehiscing by one (the higher) pore; *lower*, dehiscing by two (the lower) pores.

Examine one of the seeds with lens, and—

Observe 1. Form [oblong, and as if cut off at the top (*truncate*)].
2. Surface [beset with short hard points (*muricate*)].

Make a longitudinal section, and—

Observe 3. Minute straight *embryo* (with *two* cotyledons) situate at narrow end.
4. *Albumen* taking up rest of contents of testa.

Write description of plant to accompany sketches.

Description.

Stem—Erect, woody, glabrous below, herbaceous and hirsute above, branching.

Leaves—Cauline; *lower* opposite; *upper* alternate; petiolate, simple, narrow-lanceolate, entire, smooth, glabrous, exstipulate.

Inflorescence—A raceme; *flowers* pedicellate, bracteate; *bracts* ovate, acuminate.

Calyx—Inferior, gamosepalous, five-partite, irregular, hirsute.

Corolla—Hypogynous, gamopetalous; *limbs*, five, saccate, bilabiate, personate; *palate* hirsute, yellow.

Stamens—Epipetalous, four, didynamous; *filaments* bent near base; *anthers* oblong.

Disk—Inferior, annular, green.

Pistil—Superior; *ovary* ovate, two-celled; *ovules*, many, on axillary placentæ; *style* long, simple; *stigma* two-lobed.

Fruit—A capsule dehiscing by pores; *seeds*, many.

Synopsis.

The Snapdragon belongs to the Class *Dicotyledons*, because—

1. The leaves have branching veins.
2. The parts of the perianth are in fives.
3. The embryo has two cotyledons.

The Snapdragon belongs to the Division *Gamopetalous*, because—

1. It has both a calyx and corolla present.
2. The petals are united.

The Snapdragon belongs to the Natural Order *Scrophulariaceæ*, because—

1. The corolla is irregular.
2. The stamens are fewer than the corolla lobes.

3. The ovary is two-celled.
4. The ovules are many, attached to an axile placenta.
5. The fruit is capsular.
6. The seeds are albuminous, with a straight embryo.

List of other Plants belonging to the Natural Order Scrophulariaceæ.

I. The Speedwells.—Herbs, with erect or prostrate stems, opposite leaves, and small blue flowers, with rotate corollas, on axillary or terminal racemes, species of which may be found in waste places, pastures, woods, and borders of cultivated ground; in flower from March to September.

Observe 1. Leaves opposite.
2. Corolla deeply four-cleft, with very short tube.
3. Stamens, only two, inserted on corolla-tube on each side of upper lobe, widely divergent, and protruding out of corolla (exserted).
4. Capsule flattened laterally (at right angles to septum), dehiscing by two valves.

II. Eyebright.—A small branching annual with parasitical roots, wiry stem, opposite sessile leaves, and minute, bracteate, tubular flowers, in loose terminal spikes; found in pastures, heaths, and meadows; in flower from May till September.

Observe 1. Roots parasitic on roots of grasses.
2. Branches (opposite).
3. Calyx with *four* acute lobes.
4. Corolla two-lipped, white, with purplish veins and yellow spot in throat.
5. Stamens hidden under upper lip, each anther cell being tipped with an abrupt short point (*mucronate*).

III. The Common Rattle.—An erect glabrous annual herb, with fibrous parasitical roots, shortly branched stem, opposite lanceolate leaves, and yellow tubular flowers, in a one-sided leafy spike ; found in damp pastures and wet places ; in flower from May till July.

Observe 1. Suckers at end of parasitic roots.
2. Inflated calyx, with compressed sides and constricted throat.
3. Upper lip of corolla with a toothed appendage on each side in front.
4. Stamens, four, with hairy anthers.
5. Orbicular capsule, with two membranous valves.

IV. The Purple Foxglove.—An erect herb, with stout unbranched stem, coarse ovate leaves, the lower petiolate and crowded, the upper sessile and alternate, and large tubular pendulous flowers, in a terminal showy raceme ; found in copses and on dry hilly wastes ; in flower during July and September.

Observe 1. Corolla with its four short lobes.
2. Stamens, four, with their anthers in pairs.
3. Stigma with *two* lobes.

General Properties of Order.

Bitter, sometimes purgative, often poisonous.

Uses.

Pharmacy.—Foxglove (foliage).

Various.—Common toad-flax (said to act as a purgative), great snapdragon (from the seed of which an oil is extracted in Russia).

Garden Plants.—Alonsoa, calceolaria, hemianthus, lophospermum, monkey-flower, morandia, paulownia, pentstemon, snapdragon, speedwell (shrubby exotic species), torenia.

Distribution.

(*a*) **In Time.**—Represented in recent deposits.

(*b*) **In Space.**—Very widely dispersed within the limits of flowering plants, but specially inhabiting temperate and subtropical regions in both hemispheres.

IX.—THE WHITE DEADNETTLE.

The White Deadnettle is a herbaceous plant, with square stem, opposite, simple leaves, and white bilabiate flowers in axillary cymes; found under hedges, in fields, and waste places; in flower from April to December.

Examine (A) *STEM.*

Observe 1. Direction (erect, but procumbent at base).
2. Form (square).
3. Surface (hirsute).
4. Arrangement of branches (opposite or whorled).

Make a longitudinal section along part of the stem, letting the knife pass through one of the nodes.

Observe 5. Interior cavity running through whole length of internode (*fistular*).
6. Transverse partition at node.
7. Adventitious roots growing from under surface of nodes, on the part of the stem which is procumbent.

Examine (B) *LEAVES.*

Observe 1. Position on stem (opposite).
2. Insertion (petiolate).
3. Kind (simple).
4. Form [heart-shaped (*cordate*), terminating in a long point (*acuminate*)].
5. Surface (hirsute).
6. Margin (serrate).
7. Absence of stipules (*exstipulate*).
8. Venation (branching from mid-rib). *Sketch.*

Examine (C) *INFLORESCENCE.*

Observe 1. Clusters of definite (*centrifugal*) flowers in the axils of the opposite leaves (axillary cymes).
2. The shortly-petioled bracts.
3. The irregular white flowers. *Sketch.*

Examine (D) *FLOWER.*

(*a*) **Calyx.**

Observe 1. Position (inferior).
2. Cohesion of sepals (gamosepalous), forming a short-ribbed tube, with long tapering teeth.
3. Number of teeth (five).
4. Surface (hirsute). *Sketch.*

Push a needle down one side of calyx-tube, and split it upwards from base. Make a similar longitudinal slit on opposite side, and pull or dissect away the anterior half. This will expose insertion of—

(*b*) **Corolla.**

Observe 1. Cohesion of petals (gamopetalous), forming a long, bent, gradually dilating tube.
2. Form of limb [two-lipped (*bilabiate*), the lips widely separate or gaping (*ringent*)].
3. Form and position of lips (the spreading, notched under lip, and the two lateral, toothed lobes, *alternate* with the calyx teeth, and the upper, arched, hood-like lip, contracted at base opposite to one of the posterior sepals).
4. Number of petals (five, alternate with the sepals).
5. Colour (white). *Sketch.*

Open the corolla in front by making a careful longitudinal incision with cutting needle, commencing at base, and passing upwards through and equally bisecting the under lip. Dissect neatly round the ovary, so as to well expose it, taking care not to detach style; spread out the corolla, and pin it back to a card.

Observe 6. Insertion (hypogynous).

7. Ring of hairs inside at base of tube, a little above the ovary.

(*c*) **Stamens.**

Observe 1. Number (four).

2. Difference in length [two long and two short (didynamous)].
3. Insertion upon corolla (epipetalous), the two longer being anterior, the two shorter posterior.
4. Direction of filaments [ascending, parallel, and arching under the upper lip, bringing the anthers together in pairs (*connivent*)].
5. Divergence of the two hairy anther cells by enlargement of the upper part of filament (*connective*).
6. Dehiscence (each cell by a longitudinal slit).

(*d*) **Pistil.** *Sketch.*

Observe 1. Position (superior).

2. Ovary, with deep clefts, separating it into four lobes (four-partite).
3. Long slender style springing from between the lobes, and arching above, under the upper lip, between the filaments.
4. Forked stigma.

Remove two of the ovary lobes, and—

Observe 5. Insertion of style [from centre, and at base of lobes (gynobasic)]. *Sketch.*

Selecting a flower from which the corolla has fallen, carefully dissect away one side of the persistent calyx.

Observe (*e*) **Annular Disk,** upon which the ovary is seated.

With a sharp knife make a transverse section across the four ovary lobes.

Observe 6. Number of cells (four, one in each lobe).

7. Number of seeds (four, one in each cell). *Sketch.*

Take a well-developed lobe from another flower, and with dissecting needles carefully remove one side of the ovary wall.

Observe 8. The solitary erect ovule, growing by a short stalk (funiculus) from floor of cell (*basal-placentation*).

Examine (E) *FRUIT* (nutlets).

Observe 1. Position inside, and at base of persistent calyx-tube.
2. Form of nutlets [tapering at base, broad as if cut off at apex (*truncate*)]. *Sketch.*

Place one of the nutlets in a notch in a piece of cork, and with a sharp knife make a longitudinal section; carefully remove seed from each section, and—

Observe 1. Membranous testa.
2. Embryo, with its two fleshy cotyledons, small plumule, and tapering radicle, making up whole contents of seeds (*exalbuminous.*) *Sketch.*

Write a description of plant to accompany sketches.

Description.

Stem—Erect, procumbent at base, square, fistular, hirsute; *branches* opposite or whorled.

Leaves—Cauline, opposite, petiolate; *petioles*, *in lower* long, *in upper* short; simple cordate, acuminate, hirsute, serrate, exstipulate.

Inflorescence—Opposite, axillary cymes; *flowers* irregular, bracteate; *bracts* shortly petiolate.

Calyx—Inferior, gamosepalous, persistent, tubular, hirsute, ribbed, five-toothed; *teeth* long, tapering, acuminate.

Corolla—Hypogynous, gamopetalous; *tube* long, bent, dilated, with ring of hairs inside, above base; *limb* bilabiate; *under lip* spreading, notched; *upper lip* arched, hood-like, contracted at base.

Stamens—Epipetalous, four, didynamous; *filaments* ascending, parallel, arched under upper lip; *anthers* connivent, two-celled, hirsute, divergent, dehiscing longitudinally.

Pistil—Superior, syncarpous; *ovary* four-partite, four-celled; *ovules* basal, erect, solitary in each cell; *style* long, gynobasic; *stigma* forked.

Fruit of four nutlets, enclosed in a persistent calyx-tube; *seeds* exalbuminous.

Synopsis.

The White Deadnettle belongs to the Class *Dicotyledons*, because—

1. The leaves are net-veined.
2. The parts of the perianth are in fives.
3. The embryo has two cotyledons.

The White Deadnettle belongs to the Division *Gamopetalæ*, because—

1. A calyx and corolla are both present in the flower.
2. The petals are united.

The White Deadnettle belongs to the Natural Order *Labiatæ*, because—

1. It is a herb, with square stem.
2. The leaves are opposite and exstipulate.
3. The flowers are in opposite cymes.
4. The corolla is bilabiate.
5. The ovary is four-lobed, and the style gynobasic.
6. The fruit consists of nutlets enclosed in the persistent calyx.

List of other Plants belonging to the Natural Order Labiatæ.

I. Purple Deadnettle.—A spreading annual, very common as a garden weed; flowering in early spring, and throughout the whole season.

II. Mint.—Strongly-scented perennial herbs, with small flowers in dense whorls, found wild or cultivated; in flower during the summer and autumn.

Observe the sessile leaves and spikate flowers in Horsemint, and the shortly petiolate leaves in Peppermint.

III. Wild Sage.—An erect, coarse, slightly branching herb, with lower petiolate, and upper sessile, much wrinkled leaves, and small, blue, whorled flowers, in terminal, bracteate spikes; found in waste places; in flower from June till September.

Observe 1. The two-lipped calyx.
2. The peculiar structure of the stamens (really only two, each having a very short filament and a long slender connective, which separates the two anther cells; one (aborted) is placed over the entrance to the corolla-tube, the other is carried upwards under the hood-like lip).

IV. Self-Heal (Common Prunella).—A low, branching, hairy perennial, with creeping rootstock, and erect flowering branches, lower petiolate and upper sessile nearly entire leaves, and violet purple flowers in cylindrical spikes; found in pastures and waste places; in flower from July till September.

Observe 1. The stamens protruding out of the corolla (exserted).
2. The two-fid filaments.

General Properties of Order.

Stimulant, fragrant, aromatic, sometimes bitter and tonic.

Uses.

Plants belonging to this Order abound in highly-fragrant volatile oils, contained in special glands. No plants belonging to it are hurtful.

Hyssop, marjoram, mint, penny-royal, sage, savory, and thyme are culinary herbs. Wood-sage is used as a substitute for hops. White horehound is used as a rustic cough medicine. Lavender, peppermint, rosemary, and spearmint are used in Pharmacy. Motherwort, sage, and many exotic species of great beauty are cultivated as ornamental plants.

Distribution.

(*a*) **In Time.**—Represented only in deposits of the present age.

(*b*) **In Space.**—Widely distributed, but especially abounding in the warmer temperate regions. Rare in cold climates.

X.—THE WHITE GOOSEFOOT.

The White Goosefoot is an erect, branching, more or less mealy annual, from one to three feet high, with tough fleshy stem, alternate exstipulate leaves, and small pale-green clustering flowers, in short axillary and terminal spikes; found in flower from July to September, in waste places, and especially near cultivated ground.

Examine (A) the erect branching *STEM.*

Observe 1. Its succulent character.

2. The presence of distinct longitudinal ridges and stripes.
3. The more or less abundance on surface of white, mealy-looking grains.

Examine (B) the *LEAVES.*

Observe 1. Position on stem (alternate).

2. Insertion (by short furrowed petioles).
3. Kind (simple).
4. Difference in form between lower and upper:
    (*a*) *upper*, ovate and toothed.
    (*b*) *lower*, linear and entire.
5. Surface (glabrous, but covered, especially on the under, with mealy grains).
6. Venation (branching).
7. Absence of stipules (exstipulate). *Sketch.*

Examine (C) the *INFLORESCENCE.*

Observe 1. How the minute flowers are crowded, and sessile upon short axes (*spikes*).

2. The absence of bracts (ebracteate).
3. That the spikes grow from the axils of the leaves,

and also terminate the stem and flowering branches.

4. The pale-green or mealy-white appearance of the whole inflorescence. *Sketch.*

Selecting a spike having fully expanded flowers, pull it off and proceed to examine—

(D) A *FLOWER.*

Observe (*a*) The single green **Perianth** (no corolla being present) or **Calyx.**

Note 1. Number of sepals (five).

2. Union of sepals at base (connate).

3. Position of calyx (inferior). *Sketch.*

Examine a flower just beginning to expand, and, using a needle—

Note 4. Imbricate arrangement of sepals in bud.

(*b*) The **Stamens.**

Note 1. Position [opposite to the sepals, and equal to them in number (five)]. *Sketch.*

With cutting needle carefully remove one of the sepals, and—

Note 2. Insertion of stamens upon calyx (perigynous).

3. The awl-shaped filaments (subulate).

4. The two-celled anthers.

(*c*) The syncarpous **Pistil** (evident by the presence of free stigmas).

Note 1. Position (superior).

2. Form of ovary (globose).

3. The short styles (two or three). *Sketch.*

With a sharp knife make a longitudinal section of ovary, or dissect out with needles under simple microscope.

Note 4. The ovary is one-celled.

5. The solitary ovule growing from the floor of cavity (basal). *Sketch.*

Examine (E) *FRUIT* (utricle).

Observe 1. Outer covering or whorl of persistent keeled sepals. *Sketch.*

Pull back the sepals, and take out the utricle.

Note 1. Kind (dry, indehiscent).
2. Form (orbicular).
3. Nature of pericap (thin and membranous). *Sketch.*

Dissect the pericarp away, and observe—
4. Fruit is one-celled.
5. Solitary seed (which completely filled the cell).

Examine (F) *SEED.*

Note 1. Hard or crust-like (crustaceous) testa.
2. Pointed protuberance (*the radicle*) at base.

Place the seed in a notch in a piece of cork, and with a sharp knife make a longitudinal section.

Note 3. Floury albumen in centre.
4. Embryo lying immediately within the testa, and forming a ring (*annular*) round the albumen.
5. Radicle.
6. Cotyledons (two). *Sketch.*

Select an unripe fruit, and extract the soft seed. Carefully dissect the testa away with cutting needle, and lift out the embryo. The parts of the embryo can now be well seen and examined.

Write a description of plant to accompany sketches.

Description.

Stem—Erect, branching, succulent, ridged, striped, mealy.

Leaves—Cauline, alternate, petiolate; *petioles* short, furrowed; *blade*, *lower* ovate-toothed, *upper* linear, entire; upper surface glabrous, under surface mealy, exstipulate.

Inflorescence—Spicate; *spikes* axillary and terminal; *flowers* small, green, crowded, ebracteate, mealy.

Perianth—Inferior; *segments* five, connate, green, imbricate.

Stamens—Five, opposite sepals, perigynous; *filaments* subulate; *anthers* two-celled.

Pistil—Superior, syncarpous; *ovary* globose, one-celled; *ovule* solitary, basal; *styles*, two or three.

Fruit—A utricle enclosed in a persistent calyx, ovate, laterally compressed; *pericarp* membranous; *seed* solitary; *testa* crustaceous; *albumen* floury; *embryo* annular.

Synopsis.

The Goosefoot belongs to the Class *Dicotyledons*, because—
1. The veins of the leaves are branching or reticulated.
2. The parts of the perianth are in fives.
3. The embryo has two cotyledons.

The Goosefoot belongs to the Division *Incompletæ*, because—
1. The flowers have only a single perianth.

The Goosefoot belongs to the Natural Order *Chenopodiaceæ*, because—
1. The leaves are exstipulate.
2. The flowers are inconspicuous and clustering.
3. The perianth segments are small, green, and imbricate in bud.
4. The stamens equal in number the perianth segments, and are opposite to them.
5. The ovary is one-celled, with a solitary basal ovary.
6. The embryo is curved.

List of other Plants belonging to the Natural Order Chenopodiaceæ.

I. Wild Beet.—A leafy herb, with branched angular stem, and large, shiny, fleshy, radical, and narrow cauline leaves, on broad petioles, and small, green, clustering flowers, on spicate inflorescence; found in muddy sands by the sea-shore; in flower from June to October.

N.B.—The White and Red Beets, and the Mangel Wurzel, are cultivated varieties of this plant.

Observe 1. Presence of bracts.
2. Adhesion of ovary to base of persistent perianth, and induration of latter in fruit.

II. Common Orach. — A mealy annual, with spreading branches, petiolate leaves, and clustering flowers in slender spikes; found in waste ground near cultivated places, on or around old manure heaps, etc.; in flower from June till October.

Observe 1. The flowers are one-sexual and ebracteate.
2. Compressed utricle enclosed between two enlarged persistent sepals.

General Properties of Order.

Harmless.

Uses.

Beet (root) for salad; mangel wurzel (root) for cattle; orach, spinach, and some species of goosefoot as pot-herbs. Sugar is extensively manufactured from beet-root, especially in some countries on the Continent.

Distribution.

(*a*) **In Time.**—Represented in the younger life period or tertiary formations.

(*b*) **In Space.**—Widely dispersed throughout the world, and especially inhabiting maritime and other saline districts.

XI.—THE COMMON HAZEL.

THE Common Hazel is a deciduous shrub or low tree, with long, slender, flexible branches, alternate, broad, doubly-serrate leaves, and monœcious flowers, the male in long cylindrical catkins, the female in small bud-like tufted cones; found in woods, thickets, and hedges; in flower during February and March, and therefore before the appearance of the foliage leaves.

Procure a catkin-bearing branch, and examine.

Observe (A) The woody branch, slender and flexible.
(B) The leaf-buds.
(C) The long, cylindrical, pendulous catkins (staminate inflorescence).
(D) The bud-like cones, on the sides or end of branch, having bright-red tufts (the styles) protruding from their apices (pistillate inflorescence).

Sketch.

Examine (B) a *LEAF-BUD.*

Note the oblong scales, with rounded (obtuse) apices, protecting the enclosed rudimentary foliage leaves [the *stipules*, which soon fall away after the bud begins to expand (deciduous)].

Sketch.

Examine (C) *MALE INFLORESCENCE.*

Select a catkin having open flowers—

Observe (*a*) The elongated unbranched peduncle.
(*b*) The concave sessile scales (*bract* leaves), spirally crowded along peduncle.

Remove a bract, and—

Note 1. Form [wedge-shaped (cuneate)].
2. Surface (hairy).

Examine inner (concave) side (using lens).

Observe (α) The two smaller scales (bracteoles), adnate to bract.

(β) The short stamens, also adnate to bract (a perianth being absent).

Note 1. The short filaments.

2. The one-celled anthers, hairy at tip.

3. Number of stamens (apparently eight, with one-celled anthers; but really four, with split two-celled anthers, and deeply-forked filaments).

Sketch.

Examine (D) *FEMALE INFLORESCENCE.*

Observe (*a*) Outer overlapping scales (bracts). Remove one or two.

Note 1. Absence of flowers in their axils (sterile).

2. Resemblance to bud scales.

Remove all the sterile bracts (at least from one side)—

Observe (*b*) Inner fertile bracts, narrow, sessile, and closely packed in upper part of cone, each having in its axil a pair of flowers.

(*c*) Two coherent bracteoles (involucre) at base of each flower.

(*d*) Flowers (pistillate) minute, densely hairy, and lying very closely together.

Remove, very carefully, one of the flowers (with involucre) and examine (with lens).

Note 1. Size of involucre (small), also its deeply cut and jagged upper margin.

2. Whorl of minute teeth (indication of superior and adnate calyx) round upper part of ovary.

3. The inferior hairy ovary somewhat globular in form.

4. Two long bright-red styles (denoting that the pistil is formed of two coherent carpels). *Sketch.*

Examine (E) the *FRUIT* (a nut).
Observe 1. The enlarged lobed and jagged leafy involucre (the husk) enclosing nut. *Sketch.*
Remove nut and examine.
Observe 2. Kind (dry and indehiscent).
3. Form.
4. Woody character.
Break the 'shell,' remove seed, and examine.
Observe 1. Form.
2. Testa (thin).
3. Longitudinal split in embryo separating the two cotyledons.
Insert knife in slit, and part the cotyledons.
Observe 4. Short radicle at upper end. *Sketch.*
Write a description of plant to accompany sketches.

Description.

A deciduous shrub or low tree.

Branches—Slender, flexible, hispid.

Leaves—Alternate, shortly petiolate, simple, broadly obovate, doubly-serrate, coarse, downy, stipulate; *stipules* oblong, obtuse, deciduous.

Flowers—Monœcious.

Male Flowers—In long, cylindrical, pendulous catkins; *bracts* cuneate, hirsute; *bracteoles* adnate to bracts; perianth, none; *stamens*, eight, adnate to bract; *filaments* short; *anthers* one-celled, hairy.

Female Flowers—In bud-like cones; *bracts* sterile or fertile; *fertile bracts* sessile, narrow; *bracteoles*, two, forming an involucre deeply cut, jagged, enlarging in fruit; *perianth* superior; *ovary* inferior, globular, hirsute [two-celled *ovules*, one in each cell, or none in one and two in other]; *style*, two, bright-red.

Fruit—A woody nut, enclosed in a leafy, often deeply cut involucre. Seed exalbuminous.

Synopsis.

The Hazel belongs to the Class *Dicotyledons*, because—
1. The leaves are net-veined.
2. The embryo has two cotyledons.

The Hazel belongs to the Division *Incompletæ*, because—
1. The flowers have only a single perianth.

The Hazel belongs to the Natural Order *Cupuliferæ*, because—
1. It is a tree.
2. The leaves are alternate and stipulate.
3. The flowers are monœcious.
4. The ovary is inferior.
5. The fruit is dry, indehiscent, one-celled, one-seeded, and enclosed in an enlarged involucre.
6. The seed is large and exalbuminous.

List of other Plants belonging to the Natural Order Cupuliferæ.

I. Oak.—A stately, deciduous forest tree, with rugged bark, tortuous branches, sessile or shortly petiolate lobed leaves, and monœcious flowers; the male in slender pendulous catkins, the female solitary and involucrate; the flowers appearing with the leaves in April and May.

Examine (*a*) Male Flowers.
Observe 1. The six or seven-lobed calyx.
2. The ten slender stamens with two-celled anthers.
(*b*) Female Flowers.
Observe 1. The involucre (of many bracteoles).
2. The toothed perianth adnate to base of ovary.
3. The three-celled ovary, with two pendulous ovules in each cell.
4. The acorn seated in a shallow woody cup, formed of imbricating scales.

II. Beech.—A large deciduous tree, with straight trunk, flexuose, horizontal branches, alternate, ovate, shining leaves, and axillary monœcious flowers; the male in slender pendulous catkins, the female usually in pairs, enclosed in a silky involucre; flowering in April and May.

Observe the acutely three-cornered, one-celled fruits, enclosed in a hard prickly involucre.

III. Hornbeam.—A small tree, with (usually) flattened trunk and numerous short slender branches, smooth light-grey bark, shortly petiolate ovate leaves, and monœcious flowers; the male in cylindrical catkins, the female in small bud-like cones; found in shrubberies in flower in May.

General Properties of Order.

Astringent, seeds esculent.

Uses.

Esculent Seeds.—Beech, chestnut, common hazel, filberts (a variety of hazel).

Timber.—Beech (tenacious and flexible), chestnut (rather brittle), hornbeam (very tough), oak (tenacious and durable).

Fuel.—Beech, hornbeam.

Dyes.—Valonia (acorn-cups of an exotic species of oak), quercitron (a yellow dye obtained from the inner bark of a species of American oak).

Oils.—Are obtained from the fruits of beech and hazel.

Various.—Bark of oak, valonia, and oak galls, are used in tanning, their value depending upon the chemical action of a substance they contain, called tannin or tannic acid, upon the gelatine of hides, resulting in the formation of an insoluble compound, and producing leather. Oak galls are also used in the manufacture of ink, as the tannin produces a black colour with iron compounds. Cork is obtained from the bark of the cork oak. Hazel branches are used for hoops of casks, walking-sticks, etc.

Distribution.

(*a*) **In Time.**—Represented in the chalk by a species of oak.

(*b*) **In Space.**—Abundantly dispersed throughout the north temperate zone. Found along mountain ranges in some localities in the tropics, Australia, and New Zealand, but never in Central or Southern Africa.

XII.—THE SPOTTED ORCHIS.

The Spotted Orchis is a herbaceous plant, with long, slender, unbranched, leafy stem; narrow, oblong-lanceolate, chiefly radical leaves, and irregular, pale-pink, spotted flowers, in a dense oblong spike; found in moist meadows, pastures, and open woods; in flower from May till July.

Procure specimen of complete plant.

Examine (A) *ROOT.*

Observe (*a*) Two unequal, slightly flattened tubers, each divided into two or three finger-like lobes, having thus a fanciful resemblance to hands with outspread fingers (*palmate*).

(*b*) Stout fibres growing from above (*a*). *Sketch.*

Examine (B) *STEM.*

Observe 1. Direction (erect).
2. Form [round (*terete*) slender].
3. Character (herbaceous).
4. Surface (glabrous).

Examine (C) *LEAVES.*

Observe 1. Position [chiefly radical, but also on stem (cauline)].
2. Arrangement of stem leaves (alternate).
3. Insertion (by sheaths).
4. Kind (simple).
5. Form (narrow or oblong-lanceolate).
6. Margin (entire).
7. Apex (acute or obtuse).

8. Surface (glossy, glabrous, with dark markings).
9. Absence of stipules (exstipulate).
10. Venation (parallel). *Sketch.*

Examine (D) *INFLORESCENCE.*

Observe 1. Character (indefinite).
2. Kind (a spike).
3. The irregular, pale-pink (or purplish) flowers, sessile, by long twisted stalk-like ovaries, upon the flowering branch (*rachis*).
4. Presence of bracts (bracteate).
5. Form of bracts [tapering from a broad base to a sharp point (*subulate*)]. *Sketch.*

Examine (E) *FLOWER.*

Respecting the perianth—

Note 1. Position (superior).
2. Cohesion of segments (gamophyllous).
3. Number of segments (six).

Observe (*a*) Three outer, almost similar oblong-lanceolate segments (*sepals*).
(*b*) Three inner, dissimilar segments (*petals*).
  (α) Two short, lateral, ovate, and arching petals, their obtuse apices meeting (connivent) above the column (*c*).
  (β) One broad, anterior, three-lobed petal (*lip* or *labellum*), continued at base into a long slender decurved spur, containing a sweet fluid. *Sketch.*

Remove the sepals, the two lateral petals, and limb (or apron) of labellum. Also dissect away one side of upper part of spur, and—

Observe (*c*) Short column situated upon the top of the ovary, terminating below in a knob-like protuberance or pouch (*the rostellum*), which projects over the entrance to the spur.

(*d*) A depressed, viscid, shiny surface (*the stigma*) facing the entrance to the spur, and situated immediately beneath the rostellum.

Examine (*c*) **Column.**

Observe 1. Solitary two-celled anther (monandrous) situated in front of the lip above the rostellum, and adnate to an elongated portion (*style*) of the pistil, continued above the stigma (*gynandrous*).

2. Divergence of anther-cells at base.

3. Dehiscence of anther-cells (each by a ventral longitudinal slit). *Sketch.*

Introduce the point of a needle into one of the cells, and carefully remove a club-shaped body which you will find inside, and examine.

Observe 1. The pear-shaped (pyriform) mass of united pollen grains (pollinium).

2. The slender stalk (*caudicle*) terminating below in

3. A sticky knob-like gland. *Sketch.*

Tease out the pollinium with dissecting needles under lens, and—

Observe 4. Network of very fine elastic threads, ramifying throughout the whole mass, holding the grains of pollen together, and also binding them to the caudicle. *Sketch.*

With a sharp knife make a longitudinal section through entire length of column, removing only the outer wall of anther-cell, and carefully dissecting away portion of the rostellum, exposing without removing the entire club-shaped pollen mass in position.

Observe 1. Position of pollinium.

2. Insertion of gland (imbedded in a pouch filled with a sticky fluid). *Sketch.*

Take a recently expanded flower, and gently push the sharpened end of your lead pencil into the spur.

Note that the pencil when coming into contact with the rostellum pushes down the pouch in which the sticky glands are imbedded.

Withdraw the pencil.

Observe the two club-shaped bodies adhering at right angles to the pencil by their glands; watch them for a few minutes, and notice their gradual inclination towards the point of the pencil; then reinsert the pencil into the spur of the same (or of another) flower, and observe contact of pollinium with sticky surface of stigma; on removal, it will be found that some of the pollen grains have adhered to the stigmatic surface.

Repeat the above experiments, and make sketches.

Examine **Ovary.**

Observe 1. Position (inferior).
2. Form (three-angled, twisted).

Make a transverse section through upper, and—

Observe 3. Single cavity (one-celled) containing many ovules.

Open the cell with cutting needle along one side of its entire length. Pin back the margins to a card, or lay the opened ovary (with the outside below) over your forefinger, holding it in position with the thumb and middle finger, and examine.

Observe 4. Three longitudinal or parallel rows of minute ovules along whole length of the ovary wall (parietal placentation). *Sketch.*

Examine (F) *FRUIT* (a capsule).

Observe 1. Character (dry, dehiscent).
2. Mode of dehiscence [by three valves, separating from three septa (mid-ribs), which are united at base as well as at summit].
3. Number of seeds (innumerable). *Sketch.*

Take one of the seeds and examine under lens.

Observe 1. Size (minute).
2. Form [tapering to one end (fusiform)].
3. Testa (loose, with reticulate markings).
4. Round body or nucleus (undeveloped embryo) clearly seen within (3).
5. Absence of albumen (exalbuminous). *Sketch.*

Write a description of plant to accompany sketches.

Description.

Root—Tuberous and fibrous; *tubers* flattened, palmate; *fibres* stout.

Stem—Erect, unbranched, herbaceous, slender, terete, glabrous.

Leaves—Radical and cauline, alternate, sheathing, simple, oblong-lanceolate, entire, obtuse, glossy, glabrous, with dark markings, exstipulate, parallel-veined.

Inflorescence—A dense, oblong-pyramidal spike; *flowers* irregular, bracteate; bracts subulate.

Perianth—Superior, gamophyllous; *segments*, six; *sepals*, three, similar, oblong-lanceolate; *petals*, three, unequal; *two lateral*, short, ovate, connivent above the column; *one anterior* (labellum), broad, spurred, three-lobed; *lobes* toothed.

Column—Short, with projecting rostellum; *stamen* solitary, gynandrous; *anther* two-celled; *cells* diverging at base, dehiscing longitudinally; *pollen-masses*, two, club-shaped; *pollinium* pyriform; *caudicles* slender, terminating below in viscid disk-like glands, embedded in a common pouch.

Pistil—Syncarpous; *ovary* inferior, long, twisted, three-angled, one-celled; *stigma* beneath the rostellum, depressed; *ovules*, many, minute; *placentas*, three, parietal.

Fruit—A capsule, dehiscing by valves, separating from three septa, united at base and summit; *seeds*, numerous, minute, fusiform, exalbuminous; *embryo* undeveloped.

Synopsis.

The Spotted Orchis belongs to the Class *Monocotyledons*, because—

1. The leaves are parallel-veined.
2. The whorls of the perianth are in threes.

The Spotted Orchis belongs to the Division *Petaloideæ*, because—

1. The perianth-segments are petal-like (petaloid).

The Spotted Orchis belongs to the Natural Order *Orchidaceæ*, because—

1. The flowers are two-sexual and irregular.
2. There is only one stamen, and that is adnate to the style, forming a 'column.'
3. The pollen grains are strung together, forming club-shaped masses.
4. The ovary is inferior and one-celled.
5. The fruit is capsular.

List of other Plants belonging to the Natural Order Orchidaceæ.

I. Purple Orchis (sometimes called 'Early Orchis').—A showy plant, with rather broad, usually spotted leaves, and reddish-purple irregular flowers, in a loose spike; found in moist woods, pastures, and shady places; in flower from April till June.

Observe 1. The ovoid entire tubers.
2. The one-nerved, coloured bract.
3. The spreading (sometimes recurved) lateral sepals.

II. Bee Orchis.—A plant varying in height from six to eighteen inches, with a few short oblong or lanceolate leaves, and from three to six large showy bracteate flowers, in a long loose spike; found in dry, calcareous soils; in flower during June and July.

Observe 1. The entire ovoid tubers.
2. The spreading (or reflexed) sepals.
3. The small, narrow, nearly erect petals.
4. The perpendicular and (usually) convex lip.
5. Absence of a spur.
6. The erect column, with hooked beak above the anther.
7. The pollen glands inserted in separate pouches.

8. Absence of a projecting rostellum.
9. The untwisted ovary.

Note.—Examine a flower after the dehiscence of its anther cells has taken place. Observe the escaped pollen-masses, firmly attached by their glands, swinging in front of the depressed stigma. Blow upon them, and see the pollinium strike against the viscid stigmatic surface.

III. Fragrant Orchis.—A widely-dispersed plant, with narrow, lanceolate leaves, and bright-purple, sweet-scented flowers, in narrow, cylindrical spikes; found on heaths and dry pastures; in flower all the summer.

Observe 1. The palmate tubers.
2. The long slender spur.
3. The free, exposed pollen glands (not enclosed in pouches).

IV. Lady's Slipper.—A rare (almost extinct) plant, with fibrous, creeping rootstock, large, oblong, ribbed, acuminate leaves, and one (rarely two) showy bracteate flower, on long peduncles; found in limestone districts, in only a few counties in England; flowering in early summer.

Observe 1. The large inflated lip.
2. The curved column, with two lateral, partially two-celled anthers.
3. The flat, circular, pedicelled stigma.
4. The straight ovary.

General Properties of Order.

Unimportant, but some are nutritive, and a few are aromatic.

Uses.

Salep is obtained from the mucilaginous and farinaceous tubers of some species.

Vanilla, used to flavour cocoa, chocolate, ices, biscuits, creams, etc., is the fragrant capsules of tropical American species.

Many are valued as ornamental plants, on account of their beautiful and often grotesque flowers, which for depth and brilliancy of colour are seldom surpassed. The following may be specially mentioned :—Brassia, Catesetum, Cattleya, Epidendrum, Lœlia, Maxillavia, Odontaglossum, Oncidium, Trichop.

Distribution.

(*a*) **In Time.**—Not represented.

(*b*) **In Space.**—Very widely distributed throughout the world, excepting in very dry and very cold regions.

XIII.—THE WILD HYACINTH OR BLUEBELL.

The Wild Hyacinth is a herbaceous plant, with linear, concave, radical leaves, and drooping blue racemose flowers, arranged along one side of a tall solitary scape; in flower from April to June, and found abundantly on banks and in woods, hedges, and other shady places.

Dig up a specimen. Wash roots and bulb, taking care to remove only the earth.

Observe (A) external appearance of *BULB* (underground stem).

Note 1. Form (round).
2. Covering (membranous brown coat).
3. Base of shortened stem.
4. Fibrous roots springing from 3.
5. Leaves and scape springing from centre of upper surface. *Draw.*

Make a longitudinal section, passing the knife upwards through stem, and equally bisecting bulb.

Note 6. Short conical stem.
7. Scale leaves growing from (6), filled with a clammy juice.
8. Peduncle growing from (6). *Draw.*

Make a transverse section of another bulb, and observe how the leaves sheath one another (*tunicate*). *Draw.*

Examine (B) *LEAVES.*

Make out following characters :—
1. Position (radical).
2. Kind (simple).
3. Form (linear and concave).
4. Surface (smooth, glabrous, shiny).
5. Margin (entire).
6. Venation (parallel veined). *Draw.*

Examine (C) *FLOWERING STEM.*

Note 1. Length of scape (longer than leaves).
2. Kind of inflorescence (raceme).
3. Presence of bracts (in pairs).
4. Presence of short pedicels (curved in flower, and erect in bud and fruit). *Draw.*

Make a transverse section of a flower-bud, and observe imbricate arrangement of perianth leaves. *Draw.*

Select (D) a fully expanded *FLOWER.*

Note 1. Form of perianth (bell-shaped).
2. Character of perianth (petaloid).
3. Number of segments (six).
4. Arrangement of segments (in two series of three each).
5. Cohesion of segments (slightly connate at base). *Draw.*

Dissect or pull away one or more of the perianth leaves.

Note 6. Insertion of perianth (inferior).
7. Adhesion of stamens to perianth leaves (*epiphyllous*).
8. Number of stamens (six, one on each perianth leaf).
9. Form of filaments [awl-shaped (*subulate*)].
10. Form of anthers (oblong).
11. Dehiscence of anthers on side towards pistil (introrse) [use lens]. *Draw.*

Dissect all the perianth leaves away, *excepting one* to show insertion of ovary.

Note 12. Position of pistil (superior).
13. Form of ovary (ovoid).
14. Form of style [thread-like (*filiform*)].
15. Minute stigma. *Draw.*

Remove perianth leaf, and make transverse section of ovary.

Note 16. Cohesion of carpels (syncarpous).
17. Number of cells (three).
18. Arrangement of ovules (two rows in each cell).
19. Placentation (axile). *Draw.*

Select an ovary which is just passing into fruit. With a sharp-pointed knife carefully cut into and remove the outer wall of one of the cells.

Note 20. Double row of ovules attached to inner angle of cell.

Procure (E) *FRUIT* (capsule), and examine.

Note 1. Form (roughly globose and three-angled).
2. Number of valves (three).
3. Number of seeds (one, two, three, or more in each cell).
4. Form of seeds (ovoid).
5. Colour of testa (black).

Make a longitudinal section of seed.

Note 6. Small embryo (at narrow end).
7. Fleshy albumen (making up rest of contents of testa).

Draw.

In another seed carefully dissect out the embryo. Remove and examine with lens.

Note 1. Form [round (terete)].
2. Cotyledon (single).

Write a description of plant to accompany sketches.

Description.

Root—Fibrous.

Bulb—Tuberous, with membranous brown coat.

Leaves—Radical, simple, linear, concave, smooth, glabrous, shiny, entire, parallel-veined.

Scape—Long, round, glossy.

Inflorescence—A raceme.

Flowers—Pedicellate, ebracteate; *bracts* triangular, sessile, in pairs; *pedicels* short, curved in flower, erect in bud and fruit.

Perianth—Inferior, bell-shaped; segments, six, in two rows.

Stamens—Six, epiphyllous; *filaments* subulate; *anthers* oblong, introrse.

Pistil—Superior, syncarpous; *ovary* ovoid, three-celled, with double row of ovules in each cell, and axile placentation; *style* filiform; *stigma* minute.

Fruit—A capsule, roughly globose, three-angled, three-valved.

Seeds—Several in each cell, ovoid, black, albuminous; *embryo* small, terete.

Synopsis.

The Wild Hyacinth belongs to the Class *Monocotyledons*, because—

1. The leaves are parallel-veined.
2. The whorls of the perianth are in threes.
3. The embryo has only one cotyledon.

The Hyacinth belongs to the Division *Petaloideæ*, because—

1. The perianth is petaloid and coloured.

The Hyacinth belongs to the Natural Order *Liliaceæ*, because—

1. The perianth is inferior, and of six similar segments.
2. The number of stamens is six, and one is placed opposite each segment.
3. The ovary is superior, and three-celled.
4. The fruit is capsular.

List of a few other Plants belonging to the Natural Order Liliaceæ.

I. Butcher's Broom.—An evergreen shrub, found wild in woods, etc., but often cultivated in gardens; in flower from February to April.

Observe
1. The minute scale-like leaves (seen best in young shoots).
2. The leaf-like branches (*cladodes*) borne in the axils of (1), and terminating in sharp points.
3. The minute diœcious flowers (the staminate and pistillate flowers being on different individuals).
4. The cohesion of filaments of stamens into short tube.

Note.—This plant is the only British shrub belonging to the Class *Monocotyledons*.

II. Tulip.—A handsome plant, with leafy stem, and large solitary flower; found wild in many districts, flowering in April and May, but universally cultivated as a garden plant.

III. Lily of the Valley.—A plant with long sheathing radical leaves, and pure milk-white drooping racemose flowers, on slender scape; found in woods; flowering during May and June.

IV. Herb Paris.—A plant with white creeping rootstock, and whorl of broadly ovate leaves; found locally in woods, flowering during May and June.

Observe 1. The net-veined leaves.
2. The anomalous character of floral whorls (in fours).
3. The fruit is a berry.

V. Meadow Saffron.—A bulbous herb, with pale, purple, solitary flowers, appearing in the autumn at a time when the plant is leafless.

Observe 1. Long corolla tube springing from top of corm.
2. Position of stamens on mouth of perianth.
3. Underground ovary within base of (1).
4. Arrival of capsule above ground after the leaves appear.

General Properties of Order.

Various.

Uses.

Food.—Asparagus, onions, leeks, chives (the leaves for soups), garlic (for sauces, and as a rustic medicine).

Pharmacy.—Aloes (juice from leaves), squill (bulb), colchicum (corm), veratrum (root).

Garden Plants.—Crown imperial, fritillary, hyacinth, lily of the valley, snakes-head, Star of Bethlehem, tulip.

Various.—New Zealand flax (a fibre for cordage, baskets, etc.), grass-wrack, a British marine plant (used for packing and to stuff beds).

Distribution.

(*a*) **In Time.**—Represented by remains of one genus (*yucca*) in the triassic formation.

(*b*) **In Space.**—Found abundantly dispersed throughout the tropical and temperate zones of both hemispheres.

XIV.—THE COMMON COTTON-SEDGE.

THE Common Cotton-Sedge is a perennial herb, with erect, unbranched stem, radical and cauline sheathing leaves, and small glumaceous flowers, in dense sessile or pedunculate spikes, with conspicuous tufts of long white cottony hairs in fruit; found in bogs and wet moors; flowering during May and June.

Examine (A) *ROOTSTOCK.*
Observe 1. Direction (creeping).
2. Size (stout).

(B) *STEM.*
Observe 1. Direction (erect).
2. Character (*solid*, rigid, unbranched).
3. Form (three-angled).
4. Surface (smooth).

(C) *LEAVES.*
Observe 1. Position (chiefly radical, a few cauline).
2. Insertion (by long, tubular, *unsplit* sheaths).
3. Kind (simple).
4. Form (linear-lanceolate, more or less triangular, but with a distinctly three-angled tip).
5. Surface (smooth, flat, glabrous).
6. Margins (entire).
7. Venation (parallel-veined).
8. Absence of ligules. *Sketch.*

(D) *INFLORESCENCE.*
Observe 1. Tuft of several or many ovoid or oblong dense

spikelets—the inner ones sessile, the outer ones more or less stalked (pedunculate) and often drooping.

2. Outer leafy bracts.
3. Imbricate arrangement of scaly lead-coloured bracts (*glumes*) round the flowering stalk or rachis. *Sketch.*

Carefully remove a few glumes from the rachis, and in the axil of each—

Observe 4. A small two-sexual flower (*floret*).

Note.—The two or three lowest glumes are empty (barren).

Examine (E) one of the *FLORETS* (and *GLUME*).

Observe (*a*) The concave, oblong, or ovate lanceolate membranous **Glume**, with very thin and dry (*scarious*) margins.

(*b*) The hypogynous **Perianth**, formed of many short, hair-like (*capillary*), but somewhat flattened bristles (which finally lengthen out far beyond the glumes, forming long silky-cottony tufts in fruit). *Sketch.*

Remove bristles, and

Observe (*c*) The three long **Stamens** growing from beneath the ovary (*hypogynous*).

Note 1. The flat, narrow, linear *filaments.*

2. The linear two-celled anthers, each attached by its base to the top of filament (*innate*).

3. The two anther cells dehiscing inwards (*introrse*) by longitudinal slits. *Sketch.*

Remove stamens, and

Observe (*d*) The superior **Pistil**, formed of three coherent carpels (*syncarpous*), as evidenced by the presence of three stigmas.

Note (α) The small ovate ovary.

(β) The long slender style.

(γ) The three thread-like (*filiform*) stigmas, beset with short pointed protuberances (*papillose*). *Sketch.*

Select two ovaries passing into fruit. Make a transverse section through one, and a longitudinal section through the other. Examine both under lens.

In the former, make out its one-celled character. In the latter, make out the solitary erect ovule.

Examine (F) *FRUIT.*

Note.—The long, fine, fully-grown hairs [persistent perianth whorls (E *b*)], forming white silky or cottony tufts. *Sketch.*

Remove one or two specimens of fruit, and

Observe 1. Size (small).
2. Form (triangular ovate).
3. Character (dry, indehiscent).

Carefully dissect away one side of pericarp, taking care not to detach seed.

Observe 4. Leathery (coriaceous) character of pericarp.
5. Solitary seed rising upwards from the base of the cell (*erect*). *Sketch.*

Make a longitudinal section through the seed, and examine it under lens.

Observe 1. The membranous *testa.*
2. The abundant and floury *albumen.*
3. The minute *embryo* at base of albumen. *Sketch.*

Write a description of the plant to accompany sketches.

Description.

Rootstock—Stout, creeping.

Stem—Erect, solid, rigid, three-angled, smooth, unbranched.

Leaves—Radical and cauline, sheathing, simple, linear-lanceolate, more or less three-angled, acute, smooth, flat, glabrous, entire, parallel-veined; *radical* long; *cauline* short; *sheaths* tubular, unsplit, glabrous.

Inflorescence—Of dense sessile and pedunculate spikelets, bracteate; *outer bracts* leafy.

Glumes—Oblong or ovate-lanceolate, concave, imbricate round the rachis, membranous, scarious, lead-coloured, persistent.

Perianth—Of numerous bristles, hypogynous; *bristles* short, flat, capillary; finally lengthening beyond the glumes.

Stamens—Three, hypogynous, free; *filaments* flat, narrow-linear; *anthers* linear, two-celled, innate, introrse.

Pistil—Superior, syncarpous; *ovary* ovate, one-celled; *ovule* solitary, erect; *style* slender; *stigmas*, three, filiform, papillose.

Fruit—Small, dry, indehiscent, coriaceous; *seeds* solitary, erect, albuminous; *testa* membranous; *embryo* minute.

Synopsis.

The Cotton-Sedge belongs to the Class *Monocotyledons*, because—

1. The leaves are parallel-veined.
2. The embryo has only one cotyledon.

The Cotton-Sedge belongs to the Division *Glumaceæ*, because—

1. The flowers grow in the axils of glumes.

The Cotton-Sedge belongs to the Natural Order *Cyperaceæ*, because—

1. The stem is not hollow.
2. The sheaths of the leaves are not split.
3. The flowers grow in the axils of single glumes.
4. The anthers are innate.
5. The ovary is one-celled, with one erect ovule.

List of other Plants belonging to the Natural Order Cyperaceæ.

I. Sedges (*Carex*).—A very large and widely dispersed group of perennial grass-like herbs, with leafy stems and small monœcious flowers, arranged in dense, solitary, spicate or racemose spikelets; found in wet or moist situations; flowering in spring and summer.

Examine male and female flowers, which may be found either in separate spikelets or in different parts of the same spikelet.

Observe (*a*) *Male Flowers.*—Each consisting simply of three (rarely two) stamens, with pendulous anthers, carried in the axil of a glume, and without bristles or inner scales to represent a perianth.

(*b*) *Female Flowers.*—Each consisting of a syncarpous pistil, having a one-celled ovary and erect style, enclosed in a toothed urn-shaped sac, through the open apex of which project three papillose and spreading stigmas.

(*c*) *Fruit.*—Minute, and seed-like, enclosed in the persistent sac (*perigynium*).

II. Bulrush (*Lake Scirpus*).—A tall, almost leafless water-plant, with erect, cylindrical, spongy stem, and two-sexual flowers in ovoid, or oblong spikelets, arranged in an expanding cyme; found on the margins of lakes and ponds, and in marshes and watery ditches; flowering in July and August.

Note 1. The persistent *glumes*, each tipped with an abrupt short point (mucronate), or furnished with a long bristle or awn (awned).

2. The persistent *bristle* (four or six), not exceeding the glumes in length, and not lengthening in fruit.

3. The two or three-cleft *style.*

III. Galingale or Sweet Cyperus.—A very rare, tall, rush-like herb, with erect, stout, triangular stem, and two-sexual flowers, in compressed spikelets, arranged in umbellate heads or cymes; found in wet meadows and marshes; flowering rather late in summer.

Note 1. The deciduous glumes.

2. Absence of bristles in flower.

General Properties of Order.

Unimportant.

Uses.

The rhizomes of the esculent Cyperus are full of starch, and are used as an article of food in the south of Europe.

Volatile oil is obtained from some species of Cyperus.

Papyrus (the first material used for paper) was prepared by the ancient Egyptians from the pith of a now almost extinct species of Bulrush, at one time growing abundantly on the banks of the river Nile.

The stems of the common lake Bulrush are used for making baskets, mats, bottle-covers, bee-hives, etc.

The wiry stems and leaves of several species of Sedge are used in making hassocks, mats, brushes, etc.

Sand Carex, a common species, growing abundantly on the sand-hills surrounding our coasts, is useful in binding together the shifting sand. The creeping rhizomes are sometimes used medicinally under the name of German Sarsaparilla.

Distribution.

(*a*) **In Time.**—Represented in the tertiary formations by a species of Carex.

(*b*) **In Space.**—Abundantly dispersed throughout the globe from the equator to the limits of vegetation, but found especially in moist situations, or on the edges of water.

XV.—THE COMMON WHEAT.

THE Common Wheat is an erect unbranched annual, with hollow jointed stem, sheathing leaves, and flowers in a compact square spike, cultivated as a corn plant throughout the British Isles, and found in flower during the summer.

Procure a complete plant while in flower.

Examine (A) *ROOTS*, *noting* their fibrous character.

(B) *STEM*, *observing* how it is completely encased in the long clasping sheaths of the leaves.

Remove the sheaths from the lower part of the stem.

Note 1. The distinct annular nodes from which the leaves spring.

2. The cylindrical glabrous internode.

With a knife split the stem along for some distance.

Observe 3. Solid nodes forming partitions between the hollow internodes. *Sketch.*

Examine (C) *LEAVES.*

Observe (*a*) The long tubular *sheaths* extending at least over two internodes, split in front from insertion to blade, and completely embracing the stem.

(*b*) A short membranous projection (*ligule*), passing upwards from sheath, and standing in front of the base of the blade.

(*c*) The blade.

Note 1. Kind (simple).

2. Form [linear, terminating in a long point (*acuminate*)].

3. Surface (glabrous).

4. Margin (entire).

5. Venation (parallel-veined). *Sketch.*

Examine (D) *INFLORESCENCE.*

(*a*) **Spike.**

Note 1. The sessile spikelets arranged alternately in two rows (*distichous*) along the flowering branch (*rachis*).

Remove a few spikelets.

Note 2. The compressed rachis fringed with hair (*ciliate*), showing the alternate notches upon which the spikelets sat.

(*b*) **Spikelets.**—Spread out the parts of a spikelet, and without detaching any organ—

Note 1. Two outer almost equal, and opposite inflated (*ventricose*) leaves or bracts (*outer glumes*) of leathery consistence (*coriaceous*), ovate, and ridged.

2. Short stalk, bearing three or four lateral fertile flowers, and one terminal barren flower. *Sketch.*

(E) Detach a *FLORET* from one of the spikelets, and examine.

Observe (*a*) Large inflated coriaceous bract leaf (*flowering glume*), with many (7 to 9) longitudinal nerves; its apex terminating in a short bristle or awn (*aristate*), and its margins embracing (*b*).

(*b*) Smaller membranous bract leaf (*pale*), having its margins inflected along two (one on each side) distinct longitudinal ciliate nerves, forming two keels (*bicarinate*) which terminate above in two minute points.

Note how the flaps formed by the inflated edges protect the stamens and pistil situate behind them. *Sketch.*

Remove the flowering glume, and, using lens—

Observe (*c*) Two minute ovate scale perianth leaves (*lodicules*) inserted beneath the ovary (inferior), opposite to and between the edges of the *pale.*

Note that the upper margin of each is ciliate. *Sketch.*

Using two needles (one a cutting needle), proceed to detach the pale by splitting it along the nerves, and carefully removing the pieces.

Observe (*d*) The three long stamens growing from beneath the ovary (hypogynous).

Note 1. The hair-like (*capillary*) form of filaments.

2. The pendulous anthers, each attached by one point of its back to the slender tip of the filament (*versatile*).

3. That the anthers are linear and two-celled, and that they dehisce by longitudinal slits.

Observe (*e*) The syncarpous pistil (evident by the presence of two styles).

Note 1. The superior globose ovary.

2. The two feathery (*plumose*) stigmas. *Sketch.*

With a sharp knife remove (by a longitudinal cut) one side of the ovary wall.

Note 3. The one-celled cavity, containing a solitary ovule.

(F) *FRUIT* (grain).—Soak a few grains of wheat in water for twenty-four hours, and then examine.

Note 1. Form (oblong, plano-convex).

2. On flat side a deep longitudinal groove.

3. At base of convex side a small but prominent body (the *embryo*).

4. On top a quantity of short silky hairs.

5. Membranous pericarp adhering to seed. *Draw.*

Remove pericarp, and lay bare the seed.

Next remove with cutting needle and forceps the thin testa from embryo and surrounding parts, then detach and remove the entire embryo.

Observe 1. A large hollowed-out or spoon-shaped body (the cotyledon) which lay against the albumen, in a pit at base of seed.

2. A short cylindrical axis; the upper conical portion (the *plumule*) lying in the depression of the cotyledonary leaf, the lower blunt portion (the *radicle*) being free and terminated by minute rounded protuberances. *Draw.*

Take another grain, make a longitudinal section by cutting it along the groove from below upwards, carefully bisecting the embryo, using lens.

Observe (*a*) Outer covering or *pericarp*.
Note depth of groove on plane face.
(*b*) Starchy *albumen*, forming greater part of contents.
(*c*) *Embryo* at base, lying between (*a*) and (*b*).
Note 1. *Cotyledon* forming its upper portion, and lying against albumen.
2. *Plumule* bud-like, and forming a closed bag, in the middle of which lie sheathing rudimentary leaves.
3. *Radicle*, the downward prolongation of the plumule.

Cause a dozen or so grains to germinate by keeping them moist and warm (between flannel or in cotton wool) for a few days. Examine them from time to time, and—

Observe 1. Emergence of white slender fibres from the protuberances on surface of radicle.
2. The first appearance of plumule bursting through lateral slit in outer ensheathing leaf.
3. Growth of root-hairs on radicular fibres and elongation of stem. *Draw.*

Write a description of plant to accompany sketches.

Description.

Root—Fibrous.

Stem—Erect, round, herbaceous, hollow, jointed, glabrous, glossy.

Leaves—Cauline, alternate, sheathing; *sheaths* tubular, split; *ligules* short, membranous; *blade* simple, linear, acuminate, glabrous, entire, parallel-veined.

Inflorescence—A compound spike, square; *rachis* compressed, notched, ciliate; *spikelets* sessile, compressed, distichous, several-flowered.

Outer Glumes—Ovate, ventricose, coriaceous, nerved, aristate, embracing pale.

Pale—Membranous, bicarinate, with inflexed margins.

Lodicules—Two, inferior, minute, ovate, *upper margin* ciliate.

Stamens—Three, hypogynous; *filaments* long, capillary; *anthers* pendulous, versatile, linear, two-celled, dehiscing longitudinally.

Pistil—Superior, syncarpous; *ovary* globose, one-celled, one-ovuled; *styles*, two; *stigmas* plumose.

Fruit—An achene; *pericarp* very thin, *embryo* at one side of base of copious albumen.

Synopsis.

The Wheat plant belongs to the Class *Monocotyledons*, because—

1. The leaves are parallel-veined.
2. The embryo has only one cotyledon, and the radicle on germination remains undeveloped, but throws out radicular fibres from its crown.

The Wheat plant belongs to the Division *Glumaceæ*, because—

1. The flowers grow in the axils of glumes.
2. The perianth is only represented by scales.

The Wheat plant belongs to the Natural Order *Gramineæ*, because—

1. The stem is hollow and round.
2. The sheaths are split in front.
3. The flowers are in spikelets.
4. The perianth is represented by scales.
5. The stamens are three, with versatile anthers.
6. The ovary is one-celled, and the stigmas two and feathery.
7. The embryo is on one side of the base of the albumen.

List of a few other Plants belonging to the Natural Order Gramineæ.

Note.—This Natural Order is subject to many structural variations.

It is of the greatest importance that you search for, obtain, and carefully examine all or as many of the following plants as you can, noticing wherein they agree and wherein they differ from the Wheat plant. Detailed instructions are given for the examination of the first on the list, as it is a good type of extreme modification and suppression.

I. Sweet-scented Vernal Grass.—An erect, slender perennial, from 12 to 15 inches high, with smooth stem and joints far apart, leaves pale-green and slightly hairy, panicle spike-like and of a dark-green colour in its early stages of growth; found in meadows and other grass land; flowering in spring and early summer (April to June), and often again in the autumn.

Examine one of the stalked (pedicellate) spikelets.

Note 1. Two outer, unequal glumes keeled, pointed, but awnless.
2. Two large empty flowering glumes (*sterile florets*), narrow, hairy—one with a small awn, the other with a longer awn, arising from its dorsal base.
3. One flowering full glume much smaller than the empty ones, broad, glabrous, awnless.
4. The narrow membranous pale. [Observe that (3) and (4) appear to be almost opposite to each other, like a pair of inner glumes.]
5. Absence of perianth (*lodicules*).
6. Two stamens (*only*), with large yellow anthers.
7. Glabrous ovary, long styles, feathery stigmas.

II. Meadow Grass (*Poa*).—With compressed spikelets in branched, sometimes spreading, panicles, species of which may be found in waste ground and ditches, meadows, pastures, and woods; flowering from April to September.

III. Fox-tails.—Grasses with upright cylindric close panicles, species of which may be found in meadows, pastures, and ditches; in flower from end of April to July.

Observe absence of pale and lodicules.

IV. Mat-weet.—A densely-tufted grass, found in moors, heaths, and hilly pastures; flowering during June and July.

Observe absence of empty glumes and lodicules, and presence of only one style.

V. Fescue Grass.—Many species (differing greatly in external appearance) are very common in meadows and pastures, and may be found in flower during June and July.

Observe number of stamens (1 to 3) in *Rat's-tail fescue*, found by roadsides, on walls, or in waste places.

VI. Rye Grass.—Found in waste places; flowering during June and July.

Observe close agreement in points of structure with Wheat, but note absence in spikelet of upper empty glume; examine *Italian* rye grass, a cultivated exotic species, and note abnormal structure of spikelets.

General Properties of Order.

Nutritious.

Uses.

Food.—
- (*a*) *Cereals*—wheat, oats, rye, barley, maize, rice, millet.
- (*b*) *Herbage*—the grasses.
- (*c*) *Food-adjuncts*—sugar (the clarified juice of sugar-cane), molasses or treacle (the residue of clarified juice in above), beer (by malting barley grains).

Oils.—From wheat is extracted an oil for flavouring confectionery; lemon grass oil (imported).

Pharmacy.—Wheaten flour; ergot, a parasitical fungus, found sometimes on the grains of rye.

Various.—Starch (from rice), paper (from straw). Miscellaneous articles, such as walking-canes, umbrellas, hats, brushes, chairs, etc. (chiefly made of stems).

Distribution.

(*a*) **In Time.**—Represented by species of Poa in the younger or tertiary formations.

(*b*) **In Space.**—Found in all countries within the limits of vegetation.

SYNOPSIS OF THE PRECEDING FIFTEEN NATURAL ORDERS.

CLASS I.—DICOTYLEDONS.

DIVISION I.—THALAMIFLORÆ.

(A) Pistil apocarpous.
  Order **Ranunculaceæ.** Stamens indefinite.
(B) Pistil syncarpous.
  (*a*) Placentation parietal.
    Order **Cruciferæ.** Stamens 6; tetradynamous.
  (*b*) Placentation free-central.
    Order **Caryophyllaceæ.** Stamens definite.

DIVISION II.—CALYCIFLORÆ.

(A) Ovary superior.
  (*a*) Flowers irregular.
    Order **Leguminosæ.** Stamens 10; mon- or diadelphous.
  (*b*) Flowers regular.
    Order **Rosaceæ.** Stamens indefinite.
(B) Ovary inferior.
  Order **Umbelliferæ.** Flowers in umbels; stamens 5.

DIVISION III.—GAMOPETALÆ (COROLLIFLORÆ).

(A) Ovary inferior.
  Order **Compositæ.** Flowers capitate; stamens syngenesious.

(B) Ovary superior.

Flowers generally irregular; stamens nearly always aborted, and usually didynamous.

(*a*) Ovary 2-celled.

Order **Scrophulariaceæ.** Style terminal

(*b*) Ovary 4-lobed.

Order **Labiatæ.** Style gynobasic.

DIVISION IV.—INCOMPLETÆ.

(A) Flowers 1 or 2-sexual (usually 2-sexual).

Order **Chenopodiaceæ.** Stamens one opposite to each perianth segment.

(B) Flowers 1-sexual; the male arranged in catkins, the female in cones.

Order **Cupuliferæ.** Stamens 5 to 20; fruit 1-celled and 1-seeded.

CLASS II.—MONOCOTYLEDONS.

DIVISION I.—PETALOIDEÆ.

(A) Ovary inferior.

Order **Orchidaceæ.** Anther gynandrous.

(B) Ovary superior.

Order **Liliaceæ.** Stamens 6; ovary 3-celled.

DIVISION II.—GLUMACEÆ.

(A) Flowers enclosed in one glume.

Order **Cyperaceæ.** Leaves with unsplit sheaths.

(B) Flowers enclosed in more than one glume.

Order **Gramineæ,** leaves with split sheaths.

APPENDIX.

APPENDIX.

SYNOPSIS OF THE CLASSIFICATION OF BRITISH FLOWERING PLANTS, WITH DIAGNOSES OF THE NATURAL ORDERS.

CLASS I.—DICOTYLEDONS.

Division I.—Thalamifloræ.

(A) Pistil apocarpous.

Order **Ranunculaceæ.** Herbs. Stamens indefinite; seeds albuminous.

Order **Berberideæ.** Shrubs, with alternate (or tufted) leaves. Stamens definite; anthers dehiscing by valves; carpels 1, 1-celled; seeds albuminous.

Order **Nymphæaceæ.** Aquatic plants, with floating leaves. Petals and stamens indefinite, the inner petals gradually modifying into stamens; carpels free or spuriously coherent; seeds albuminous.

(B) Pistil syncarpous.

(*a*) Placentation parietal.

Group I. The parts of the perianth (calyx and corolla) in two or multiples of two. Ovary 1-celled, or spuriously 2-celled.

Order **Papaveraceæ.** Herbs, with abundant milky juice. Flowers regular; sepals 2, deciduous; stamens numerous; seeds albuminous.

Order **Fumariaceæ.** Weak herbs, with alternate leaves. Flowers irregular; stamens 6, in two bundles; seeds albuminous.

Order **Cruciferæ.** Herbs. Stamens 6, tetradynamous; seeds exalbuminous.

Group II. The parts of the perianth in fives; calyx imbricate in bud; carpels fewer than the sepals; ovary 1-celled.

(*α*) Stamens indefinite.

Order **Resedaceæ.** Herbs, with alternate leaves. Flowers irregular; petals small, unequal, palmately divided, green; stamens seated upon a disk; seeds exalbuminous.

Order **Cistaceæ.** Shrubs, with opposite leaves. Flowers regular; sepals often only 3, but sometimes with 2 additional outer small ones; ovary partially or wholly 3 to 5-celled; stigmas 3; seeds albuminous; embryo curved.

(*β*) Stamens definite.

Order **Violaceæ.** Herbs. Leaves alternate, stipulate; flowers irregular; stamens 5, with the broad connective produced above the anther cell; style 1; capsule 3-valved.

Order **Frankenianceæ.** Herbs. Flowers regular, parts of perianth whorls in fours or fives; stamens 4 or 5, alternate with petals, sometimes 2 or 3 additional opposite petals; style 1.

(*b*) Placentation free-central.

Order **Caryophyllaceæ.** Herbs, with opposite leaves. Flowers regular; capsule 1-celled; seeds albuminous.

Order **Portulaceæ.** Herbs. Flowers regular, small; sepals 2, imbricate; petals 5 or more; ovules 2 or more.

(*c*) Placentation basal.

Order **Paronychieæ.** Herbs. Flowers regular, small; stamens 1 to 5; ovule 1; seeds albuminous.

Order **Tamariscineæ.** Shrubs, with alternate, minute, scale-like leaves; stamens 4 or more; ovules 2 or more; styles 3 to 4; capsule 1-celled; seeds with a tuft of wool.

(*d*) Placentation axile.

Group I. Ovary with many cells; parts of the perianth in fives.

(*α*) Sepals imbricate.

Order **Hypericineæ.** Shrubs or herbs, with opposite leaves. Flowers regular; stamens indefinite, polydelphous; ovary many-ovuled; seeds exalbuminous.

(*β*) Sepals valvate.

Order **Malvaceæ.** Shrubs or herbs. Leaves alternate; petals convolute, adnate to staminal tube; stamens indefinite, monodelphous; anthers 1-celled; ovary 1-ovuled.

Order **Tiliaceæ.** Trees, with alternate, stipulate leaves. Flowers cymose, bracteate; bracts leafy, adnate to peduncle; petals free; stamens indefinite; anthers 2-celled; ovary 2-ovuled.

Group II. Ovary with 5 cells; ovules 1 or 2 in each cell.

Order **Geraniaceæ.** Herbs, with stipulate leaves. Petals 3 to 5, imbricate in bud; stamens definite (10 or fewer); fruit separating in lobes or cells from a central persistent axis; seeds with little or no albumen.

Order **Linaceæ.** Slender herbs, with a tenacious bark, and narrow entire exstipulate leaves. Flowers regular; sepals imbricate; petals convolute in bud; stamens definite (4 to 5); seeds albuminous.

Group III. Ovary 2-celled.

Order **Polygalaceæ.** Herbs (often wiry) or under-shrubs. Leaves alternate, simple; flowers irregular; stamens 8, monodelphous; anthers 1-celled; ovules 1 in each cell; capsule 2-celled.

Order **Sapindaceæ** (tribe **Acerineæ**). Trees, with opposite leaves, and small regular flowers; stamens 8 to 12; ovules 2 in each cell; seeds exalbuminous.

DIVISION II.—CALYCIFLORÆ.

(A) Ovary superior. Stamens perigynous.

Group I. Ovary free, or immersed in a disk. Trees or shrubs.

Order **Celastraceæ.** Flowers regular; stamens 4 or 5, inserted on the disk; ovary 3 to 5-celled, each with *two* erect ovules; seeds albuminous.

Order **Rhamnaceæ.** Shrubs. Stipules small; flowers inconspicuous; stamens definite, opposite to the petals and inserted on the calyx; ovary 3 or 4-celled, each with *one* erect ovule; seeds albuminous.

Order **Ilicineæ** (or **Aquifoliaceæ**). Leaves alternate and evergreen; flowers small and regular; petals usually connate below; stamens definite, alternate with petals; disk absent; placentation axile; seeds albuminous.

Group II. Flowers regular or irregular; carpels one or more, usually free in bud, but may be afterwards united; styles usually free or one.

Order **Rosaceæ.** Flowers regular; stamens indefinite; seeds exalbuminous.

Order **Leguminosæ.** Flowers papilionaceous; stamens 10, mono- or diadelphous; ovary of one carpel; fruit a legume; seeds exalbuminous.

Order **Saxifragaceæ.** Flowers regular; stamens definite (*hypogynous in Parnassia*); ovary superior, half or wholly inferior, 2-celled.

Order **Ribesiaceæ.** Shrubs, with alternate leaves. Flowers regular; stamens 4 or 5, opposite to the sepals; ovary *inferior*, 1-celled, with parietal placentation; styles 2; fruit a berry.

Order **Droseraceæ.** Herbs, with glandular radical leaves. Stamens usually 5; ovary 1-celled, with many parietal ovules; fruit a capsule.

Order **Crassulaceæ.** Herbs, with succulent, exstipulate leaves. Flowers regular; stamens twice as many as the petals; carpels 3 to 5, free or slightly connate, 1-celled, with parietal placentation.

Group III. Pistil syncarpous, with a single style; ovary 1, 2, 4, or 6-celled, with numerous ovules attached to a central placenta; styles united.

Order **Lythraceæ.** Herbs, with entire, exstipulate, opposite, or whorled leaves. Petals crumpled in bud; stamens definite; ovary 2 to 6-celled, each with many ovules.

Order **Onagraceæ.** Herbs, with exstipulate leaves, and generally showy flowers. Stamens 2, 4, or 8; ovary *inferior*, usually 4-celled; style 1.

(B) Ovary inferior; stamens epigynous.

Group I. Flowers 1-sexual.

Order **Halorageæ.** Aquatic herbs, with inconspicuous, usually apetalous flowers. Stamens 1 to 8; ovary 1 to 4-celled, each with a solitary ovule.

Order **Cucurbitaceæ.** Climbing herbs, with alternate, exstipulate leaves and lateral tendrils. Flowers regular, monœcious or diœcious; stamens 3; ovary 3-celled, with many ovules; seeds albuminous.

Group II. Inflorescence usually umbellate; calyx inconspicuous; a disk is always present; ovary 2-celled, with one pendulous ovule in each cell; seeds albuminous.

Order **Umbelliferæ.** Herbs, with alternate leaves. Stamens 5; styles 2; fruit dry.

Order **Araliaceæ.** Shrubs or trees, with alternate leaves. Flowers usually green; ovary often of more than 2 cells; fruit a berry.

Order **Cornaceæ.** Herbs, shrubs, or trees, with opposite leaves. Flowers regular, in umbels, heads, or cymes; stamens 4 or 5; ovary 1 to 4-celled; style 1; fruit a drupe.

DIVISION III.—COROLLIFLORÆ (GAMOPETALÆ).

(A) Ovary inferior.

(*a*) Stamens epipetalous; ovules solitary in each cell or very few.

Group I. Corolla epigynous; stamens same number as corolla lobes; ovary 2 to 5-celled; seeds albuminous.

Order **Rubiaceæ.** Herbs. Leaves verticillate, exstipulate; corolla-lobes valvate in bud; stamens alternate with corolla-lobes; ovary 2-celled, with solitary ovule in each cell.

Order **Caprifoliaceæ.** Shrubs or herbs (often climbing). Leaves opposite, exstipulate; flowers regular or irregular, usually showy; petals valvate in bud.

Group II. Flowers capitate, often 1-sexual; ovary 1-celled, with solitary ovule.

(*α*) Stamens syngenesious.

Order **Compositæ.** Herbs. Stamens 5; ovule erect.

(*β*) Stamens free.

Order **Dipsaceæ.** Herbs, with opposite leaves. Corolla-lobes imbricate in bud; stamens same number as corolla-lobes; seeds solitary, pendulous, albuminous.

Order **Valerianeæ.** Herbs, with opposite, exstipulate leaves. Flowers irregular, cymose; corolla epigynous; stamens fewer in number than the corolla-lobes; seeds solitary, pendulous, exalbuminous.

(*b*) Stamens epigynous; ovules indefinite.

Order **Campanulaceæ.** Herbs, with milky juice, and alternate exstipulate leaves. Corolla bell-shaped, usually persistent; stamens 5; anthers dehiscing longitudinally; ovary 3 to 5-celled, but usually trilocular; placentation axile.

Order **Ericaceæ** [a sub-order (**Vaccinieæ**) including two genera]. Wiry evergreen shrubs, with alternate and exstipulate leaves. Stamens 8 or 10; ovary 4 to 5-celled.

(B) Ovary superior; stamens epipetalous.

Order **Ericaceæ** [a sub-order (**Ericeæ**) including several genera]. Stamens 8 or 10, *hypogynous;* ovary 4 to 5-celled.

(*a*) Flowers regular; stamens generally same number as corolla-lobes.

Group I. Stamens same number as corolla-lobes, or fewer; ovary usually 2-celled.

Order **Oleaceæ.** Trees or shrubs. Leaves opposite; stamens 2.

Order **Apocynaceæ.** Shrubs (usually climbing or trailing). Leaves opposite, entire; corolla 4 to 5-lobed, contorted in bud; carpels 2, distinct below (in ovary), coherent above.

Order **Gentianaceæ.** Bitter herbs, with opposite leaves. Corolla hypogynous; lobes twisted in bud; stamens alternate with corolla-lobes; ovary usually 1-celled, with numerous parietal ovules.

Group II. Stamens same number as corolla-lobes, often exserted; ovary 1 to 5-celled.

(*α*) Calyx polysepalous.

Order **Convolvulaceæ.** Twining or creeping herbs (sometimes parasitic and leafless). Sepals 5; corolla hypogynous; lobes plated in bud; ovary 2 or 3-celled, with 2 (rarely 1) ovule in each cell.

(*β*) Calyx gamosepalous.

Order **Boragineæ.** Herbs, with alternate leaves. Ovary 4-lobed, with one ovule in each lobe; style 1.

Order **Solanaceæ.** Herbs or shrubs, with alternate leaves. Ovary 2-celled; ovules indefinite; seeds albuminous.

Group III. Stamens same number as corolla-lobes, and opposite to them; ovary 1-celled, with a free-central placentation.

Order **Plumbagineæ.** Herbs (usually maritime). Ovules solitary, suspended from a basal funicle; styles several.

Order **Primulaceæ.** Herbs. Corolla hypogynous, scarious; stamens 5; style 1.

Anomalous Order **Plantagineæ.** Calyx polysepalous; sepals 4; corolla 4-lobed; stamens 4; style 1; ovary 1 to 2 or 4-celled.

(*b*) Flowers generally irregular; corolla usually bilabiate; stamens nearly always aborted, and mostly didynamous.

Group I. Ovary 1 or 2-celled; ovules very many; fruit a capsule.

Order **Scrophulariaceæ.** Ovary 2-celled; seeds albuminous.

Order **Orobancheæ.** Herbs, parasitic on the roots of other plants, and destitute of chlorophyll, with alternate scales instead of leaves; ovary 1-celled.

Group II. Ovary 4-celled, with one ovule in each cell; fruit nutlets, or a berry or drupe.

Order **Labiatæ.** Herbs, with opposite leaves. Ovary 4-lobed; style gynobasic.

Order **Verbenaceæ.** Herbs or shrubs. Ovary not lobed; style terminal.

Group III. Ovary 1-celled, with many ovules, on a free basal placenta.

Order **Lentibularineæ.** Aquatic plants, with large-looking flowers. Stamens 2; fruit a many-seeded capsule.

DIVISION IV.—INCOMPLETÆ.

(A) Perianth (calyx only) present; flowers 1 or 2-sexual.

(*a*) Ovary superior.

Group I. Flowers 1 or 2-sexual (usually 2-sexual); perianth segments imbricate in bud; ovary 1-celled; ovule solitary, erect; stigmas 2 or 3 (usually 3); seeds albuminous; embryo usually curved.

Order **Polygonaceæ.** Herbs. Leaves alternate, with sheathing membranous stipules; perianth small; stamens 6 to 10.

Order **Amaranthaceæ.** Leaves exstipulate; flowers 1-sexual, with one stamen opposite to each sepal; ovules sometimes more than one.

Order **Chenopodiaceæ.** Stipules absent; stamens opposite to the perianth lobes.

Group II. Flowers 1 or 2-sexual (usually 1-sexual); stamens opposite to perianth lobes; ovary 1 or 2-celled (usually 1-celled), 1-ovuled; stigmas 1 or 2 (usually 2); seeds generally albuminous: embryo straight.

Order **Urticaceæ.** Herbs, with (generally) a tenacious bark. Flowers 1-sexual; stamens 1, opposite to each sepal; ovules central, erect; seeds albuminous.

Order **Cannabinæ.** Herbs (sometimes twining), with a tenacious bark. Flowers 1-sexual, diœcious; male flowers with a 5-partite perianth and 5 short stamens; female flowers with a tubular entire perianth; ovule 1, pendulous; seeds exalbuminous.

Order **Ulmaceæ.** Trees, with alternate stipulate leaves. Flowers 2-sexual; ovary 2-celled, with one pendulous ovule in each cell; fruit dry, winged.

Group III. Flowers 1-sexual; perianth occasionally absent; ovules pendulous.

Order **Euphorbiaceæ.** Herbs or shrubs, often with a milky juice. Ovary 3-celled, with one or two suspended ovules in each cell; seeds with a fleshy appendage (the *caruncle*); embryo surrounded with abundant albumen.

Note.—A calyx is present in dog mercury and box.

Order **Ceratophylleæ.** Water plants, with whorled leaves. Ovary 1-celled, with one pendulous ovule.

Group IV. Flowers 2-sexual; ovary 1-celled, 1-ovuled; stigma 1; seeds with little or no albumen; embryo straight.

Order **Thymelæceæ.** Shrubs, with tenacious bark. Leaves alternate, entire, exstipulate; ovules pendulous; albumen scanty or none.

Order **Elæagneæ.** Leaves scurfy, entire, exstipulate; stamens 4 to 8; ovules erect.

(*b*) Ovary inferior.

Group I. Parasites, with or without chlorophyll; flowers 1 or 2-sexual; perianth segments valvate; ovary 1-celled; ovules 1 or many; seeds often without integument.

Order **Loranthaceæ.** Leaves entire, exstipulate;

perianth 4-lobed, with one stamen adnate to each lobe; ovule erect.

Order **Santalaceæ.** Perianth lobes 3 to 5, valvate in bud; ovules many, on a free central placentation.

Group II. Flowers 2-sexual; perianth usually coloured; stamens epigynous; ovary many-celled.

Order **Aristolochieæ.** Herbs or shrubs. Leaves alternate, exstipulate; perianth segments 3-partite, or 1 or 2-lipped, valvate in bud; stamens 6 to 12; ovary 4 to 6-celled; ovules, many.

(B) Perianth present or absent (generally absent); flowers small, 1-sexual, usually arranged in catkins (sometimes in cones or spikes); seeds exalbuminous.

Group I. Ovary inferior, 2 or 3-celled; fruit 1-celled and 1-seeded by abortion. Trees, with alternate, stipulate leaves.

Order **Cupuliferæ.** *Male* in catkins; sepals 5 or more, or wanting; stamens 5 to 20.

Order **Betulaceæ.** Flowers monœcious; stamen 1, opposite each sepal (or *scale*).

Group II. Ovary superior, 1-celled; both sexes in catkins. Trees or shrubs, with alternate leaves.

Order **Salicineæ.** Flowers diœcious; ovules basal or parietal.

Order **Myricaceæ.** Aromatic plants. Leaves resinous, glandular; perianth absent; ovule solitary, erect.

CLASS II.—MONOCOTYLEDONS.

DIVISION I.—PETALOIDEÆ.

(A) Ovary inferior. Perianth segments 6, in 2 rows, generally petaloid.

(*a*) Flowers 1-sexual. Perianth herbaceous, or with inner whorl petaloid.

Order **Dioscoreæ.** Twining plants, with broad *net-veined* leaves. Stamens 6; ovary 3-celled; styles 3.

Order **Hydrocharideæ.** Aquatic plants (floating or submerged). Perianth with a slender tube; stamens 3 (sometimes more); ovary 1, or 2, or 6-celled; styles 3 or 6.

(*b*) Flowers 2-sexual. Perianth petaloid.

Order **Orchidaceæ.** Herbs. Perianth irregular; anther gynandrous; embryo very obscure.

Group I. Herbs, with narrow leaves. Stamens 3 or 6, inserted on perianth tube; ovary 3-celled; seeds albuminous; embryo distinct.

Order **Irideæ.** Stamens 3.

Order **Amaryllideæ.** Stamens 6.

(B) Ovary superior.

Group I. Flowers small, numerous, and monœcious, in cylindrical spikes; perianth of membranous scales or hairs, or entirely absent; ovary 1 or more celled.

Order **Aroideæ.** Herbs, with spikes enclosed in a spathe. Stamens few or many; fruit succulent.

Order **Typhaceæ.** Erect marsh or water plants, with spikes *not* enclosed in a spathe. Stamens numerous; style persistent; ovule 1, pendulous; fruit dry.

Group II. Flowers 2-sexual; perianth segments in two rows, petaloid or herbaceous; stamens 6, opposite to the perianth segments; carpels 3; embryo minute; seeds albuminous.

(α) Perianth petaloid.

Order **Liliaceæ.** Herbs. Flowers usually showy.

(β) Perianth herbaceous.

Order **Juncaceæ.** Rushes. Flowers brown, small.

Group III. Water or marsh plants. Flowers with outer perianth segments herbaceous, and inner petaloid, or all herbaceous or entirely wanting.

Order **Alismaceæ.** Flowers 2-sexual; stamens 6; carpels 3, 6, or more; ovules 1 in each cell; seeds exalbuminous.

Order **Naiadeæ.** Flowers 1 or 2-sexual; perianth 4-partite, or wanting; stamens 1, 2, or 4; carpels 1, 2, or 4; ovules 1 in each carpel; seeds exalbuminous.

Order **Lemnaceæ.** Minute plants, with floating fronds. Flowers (very scarce and most minute) developed in marginal clefts of the frond; stamens 1 or 2; carpel 1, enclosed in a membranous spathe.

DIVISION II.—GLUMACEÆ.

Order **Cyperaceæ.** Herbs, with usually solid stem and unsplit leaf-sheaths. Flowers 1 or 2-sexual, in the axils of a single glume; perianth present or absent; seeds albuminous.

Order **Gramineæ.** Herbs, with usually hollow stem and split leaf-sheaths. Flowers 2-sexual; perianth of 2 minute scales; seeds albuminous.

CLASS III.—GYMNOSPERMS.

Ovary absent; ovules naked, borne on the upper side of woody scales (? carpels); pollen grains many-celled.

Order **Coniferæ.** Trees or shrubs. Leaves entire and relatively small (usually stiff and linear) and evergreen; flowers very inconspicuous; monœcious or diœcious; *males* in catkins, stamens of many sessile anthers; *females* in cones; seeds albuminous; cotyledons 2, 3, or more.

INDEX TO PLANTS.

PAGE
Anemone, Wood, 15
Apple, 44

Beech, 83
Beet, Wild, 77
Bird's-foot, Common, 36
Blackthorn, 43
Bluebell, 93
Bluebottle, 58
Bramble, 39
Broom, Butcher's, 96
Broom, Common, 36
Bulrush, 102
Buttercup, Meadow, 9

Candy-tuft, 22
Caraway, 52
Carnations, 27
Chickweed, 26
Chickweed, Mouse-eared, 27
Clover, White, 36
Coltsfoot, 57
Cornflower, 58
Cotton-sedge, 98
Cow Parsnip, 47
Cyperus, Sweet, 102

Daisy, 58
Dandelion, 54
Deadnettle, Purple, 72
Deadnettle, White, 68
Dog Rose, 44

PAGE
Eyebright, 65

Fescue Grass, 110
Foxglove, Purple, 66
Fox-tails, 109
Fragrant Orchis, 91
Furze, 35

Galingale, 102
Goosefoot, White, 74
Grass, Fescue, 110
Grass, Meadow, 109
Grass, Rye, 110
Grass, Vernal, 109
Groundsel, Common, 58

Hawkweed, 59
Hazel, 79
Hedge Parsley, 52
Hemlock, 52
Hogweed, 47
Hornbeam, 83
Hyacinth, Wild, 93

Laburnum, 37
Lady's Slipper, 91
Larkspur, 15
Lily of the Valley, 97

Marsh Marigold, 14
Mat-weet, 109
Meadow Buttercup, 9
Meadow Grass, 109

PAGE

Meadow Pea, 57
Meadow Saffron, 97
Meadow Sweet, 45
Mint, 72
Mouse-eared Chickweed, 27
Mustard, Wild, 22

Oak, 82
Old Man's Beard, 15
Orach, Common, 78
Orchis, Bee, 90
Orchis, Fragrant, 91
Orchis, Purple, 90
Orchis, Spotted, 85

Parsley, Hedge, 52
Pea, Meadow, 57
Penny-wort, 51
Pinks, 27
Prunella, Common, 73
Purple Deadnettle, 72
Purple Foxglove, 66
Purple Orchis, 90

Ragged Robin, 27
Rattle, Common, 65
Rose, Dog, 44
Rye Grass, 110

PAGE

Saffron, Meadow, 97
Sage, Wild, 72
Sedges, 101
Self-heal, 73
Shepherd's Purse, 22
Sloe, 43
Snapdragon, Great, 61
Spear Thistle, 58
Speedwells, 65
Spotted Orchis, 85
Stitchwort, Greater, 23
Strawberry, Wild, 44
Sweet Cyperus, 102
Sweet-pea, 29

Thistle, Spear, 58
Traveller's Joy, 15
Tulip, 96

Vernal Grass, Sweet-scented, 109
Vetches, 37

Wallflower, 17
Watercress, 22
Wheat, Common, 104
White Deadnettle, 68
Wood Anemone, 15

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